SILICON CHIP

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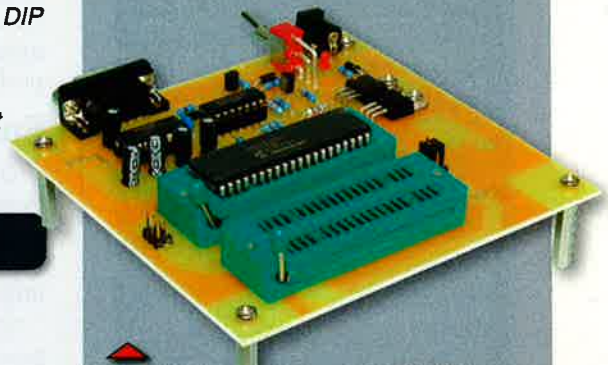

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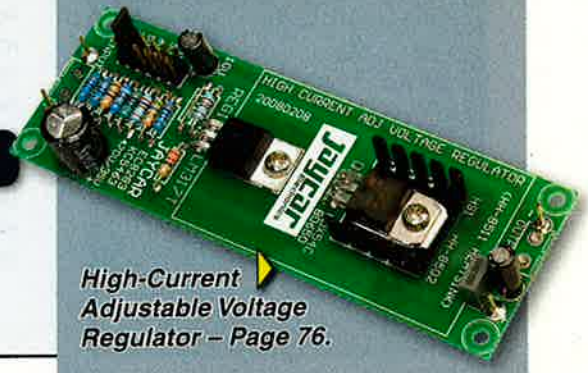

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Publisher's Letter

Vectrix motorbike is the first electric vehicle for Australian roads

This month we are very pleased to feature the story on the Vectrix battery-powered motorbike. While most people will probably be surprised at this turn of events, this is the first mass-produced electric ADR-compliant vehicle to be sold in Australia. No doubt it will be the subject of considerable debate about its merits. Does it is have enough power, range and so on?

Ultimately, these questions will be answered by its commercial success or otherwise but we think it is a very good pointer to the technology which will be featured in future electric cars. It also demonstrates that the technology does not have to be really exotic. It uses NiMH batteries and its motor control and battery-monitoring technology is nothing really special. Similar technology has been available for at least 10 years.

Of course, we would have to admit that producing an electric motorbike is a much easier challenge than producing an electric car. For example, a motorbike does not need airconditioning or a host of other power-eating devices such as power steering and braking. Nor does a motorbike need to meet today's stringent standards for crash safety. However, today's hybrid electric vehicles do meet all those requirements and it should not be an insurmountable challenge for a pure electric vehicle to do the same.

Ultimately, it will be a compromise between overall vehicle weight and overall range. The indications are that this compromise can be quite satisfactory, if you consider the Tesla Roadster now being delivered to customers in the USA. While this is an all-out performance vehicle, one can see how its technology could be satisfactorily adapted to a more mundane vehicle intended to carry four or more passengers and their luggage with reasonable performance and range.

Enersonic Power Saver does not work

On a less positive note, we also have a debunking review of the Enersonic Power Saver in this issue. We are really concerned that such products continue to appear. They appeal to people's concerns about climate change, global warming and their wish to do something positive, however small it might be.

The big problem is that most people simply do not have any concept of how electricity is generated and how various appliances actually work and consume electric energy. If a few more people in the corridors of power, for example, realised how little power is consumed by ordinary incandescent lamps in the home relative to total electric power consumption, there would never have been any move to ban them. Compact fluorescent lamps are more efficient but their wholesale adoption will have very little effect on total power consumption in most homes. Those householders who have had their incandescents changed to CFLs should already be aware of this, since their energy bills will have hardly changed, if at all.

And if people had this knowledge about electricity, the ridiculous posturing about the recent Earth Hour would have had even less significance – it was a meaningless gesture which fortunately was ignored by the majority of people.

Leo Simpson

MAILBAG

Letters and emails should contain complete name, address and daytime phone number. Letters to the Editor are submitted on the condition that Silicon Chip Publications Pty Ltd may edit and has the right to reproduce in electronic form and communicate these letters. This also applies to submissions to "Ask SILICON CHIP" and "Circuit Notebook".

Standby power in HD set top boxes

I bought a HD set-top box (Digicrystal) in Adelaide. As with the Tevion TEV8200 reviewed in the March 2008 issue, it also had a large standby wattage.

It appears that in standby mode it merely removes the program content from the video signal, so the box "appears" to start up almost instantly. All well and good, except my video set-up has an automatic switch box (Jonsa Ellies) to direct the most recently switched-on video signal (DVD, SD box/recorder, HD box) automatically to the amplifier and TV. As the video signal is always present, the auto switch box ignored the HD box after the first switch-on.

I returned the Digicrystal HD box and have since bought a Topfield TF7010HT HD set top box (also the same price – $198) which does switch to full standby and works perfectly.

I always find SILICON CHIP interesting each month and have built many kits since issue No.1.

David Lawrence,
Victor Harbor, SA.

Micro projects need more software explanation

Your February 2008 editorial raised some interesting points regarding magazine content. Firstly, as you have said, your magazine has many microprocessor-based designs and I dare say John Clarke must know just about everything there is to know about using the PIC processor considering the number of designs he has come up with. Do I think there are too many micro based projects? On balance, I would say no.

If I look back at my "pre-micro" magazines (I collected EA, ETI & AEM when they were published and of course, SILICON CHIP, for more years than I'd like to admit to), the range of projects was far more limited. I much prefer the diverse range of projects you continue to cover. I think it's a credit to you that you continue to dream them up!

As an electronic enthusiast for over 40 years, I prefer to try my hand at new things. In fact I now put together more practical projects, most using the mighty PICAXE processor, than I ever did in the past.

I often use parts of a circuit you have published and modify them for my own purpose. If a micro can save dozens of logic ICs I'm all for it and I don't consider it diminishes the excitement I get making something work.

The one criticism I do have is the lack of detailed software explanation. You seemed to put more effort into this side of your projects a few years back but I don't see it as much any more.

I use the PICAXE chip as it's very easy to program and you cover this

PICAXE circuits are not the only winners

I have noticed a big trend towards PIC-based projects. More worrying is the appearance that the only circuits that have any chance of winning the Circuit Notebook prize are those that include a PICAXE. I have been put off submitting my ideas and circuits because of this. I wonder how many of your readers are in the same boat.

I have built a lot of projects in my day and have found that microcontrolled projects tend to do what they are claimed to and have greater reliability. Is this a good thing? I'm not really sure.

I remember building the 240VAC light chaser some years ago. It was a big kit with some 300-odd components and it took a couple of days to build. What I remember most is what I learned about fault-finding in getting the thing to work. It was most frustrating but in the end rewarding and I did it myself!

Maybe we need a mix of projects and some more "back to basics" articles on microcontrollers for us old guys out there.

The other thing I have noticed with PIC kits is that their price is generally between $70 and $100. I sometimes find it hard to see the value in kits like the "PIC-Based Battery Voltage Monitor" (SILICON CHIP. May 2006) for cars which retails for around $70 when you can buy an LCD module for around $20 that will do the same job. Hobby electronics is no longer cheap and some people will find it hard to justify the growing cost of kits. So maybe some low-cost projects could be added for these readers too.

Paul Dawson,
Waurn Ponds, Vic.

Comment: with regard to the matter about Circuit Notebook items only being winners if they use a PICAXE or PIC, we can see how you could easily get that impression since there have been so many winners along those lines in the last 12 months. However, that is not intentional and we have had non-PIC winners in the March, April, May, August & December 2007 issues and in the March & April 2008 issue.

In judging the winner each month, we are looking for ingenuity and if the circuit involves a PIC/PICAXE and is ingenious, then so be it. But we would love to have a larger variety of circuits – if you have some, please send them in. Having said that, there is no guarantee that they will win or even be published (we can be hard to please . . .).

As far as kit prices are concerned, if you look at them in real dollar terms, they are still good value for money compared to kit prices of 20 or more years ago.

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quite well in your articles. If some of your simpler PIC designs gave a more thorough description of the software program and or some more tutorials on programming, it would prompt me to be more adventurous and maybe then I can try to modify your programs and hardware for my own projects.

As for your second comment on projects and technical articles, yes, I would like to see a few more articles, particularly around theory. ETI had a great series called "Lab Notes" for a few years. Even EA's "Let's Buy An Argument" series had lots of interesting technical topics.

Notwithstanding these comments, your current format with its emphasis on well-designed projects has outlived all of your competitors. Please, fine-tune as you like but keep the basic format as it is.

Finally, as I congratulate you on your 20 years of publication, I do wonder how you will eventually change over to a new guard. Most of the SILICON CHIP staff appear to go back many years and I do worry that the next generation will not have the same fascination, commitment and resourcefulness currently shown. Or are there young adults out there that share the same passion? I only hope there are.

Clive Allan,
Glen Waverley, Vic.

Comment on microcontroller projects

It has been impossible to ignore the proliferation of PIC-based projects in SILICON CHIP over the last few years. And while I agree with your reasons for basing projects around microcontrollers, there are some negative spin-offs. I don't see how PIC-based projects will offer the same opportunities to learn about circuit design, the effect of individual components on the whole or the ability to add and delete functions.

I am not suggesting that microcontroller projects should banned from SILICON CHIP! They provide a learning opportunity of a different kind, as well as projects which, as you correctly observe, would not be feasible with any other design approach. But I hope you will continue to develop and publish circuits built around conventional discrete components.

John Keitley,
Vermont, Vic.

RF projects wanted

Your Publisher's Letter in the February edition has prompted me to write. First, congratulations on reaching 20 years. I thoroughly enjoy every issue and appreciate all the hard work that goes into designing the projects as well as the rest of the magazine.

I do like microcontroller projects as I have the software and can program PICs but it would be good to balance it out with projects that use normal components too as this helps beginners learn electronics building blocks.

I am not a radio amateur but I am interested in RF stuff, as follows. How about a project for an RF oscillator for aligning AM and FM radios? Many readers have asked for a TV field strength meter. Maybe a set-top box could be modified to do it?

Impedance bridge does not measure impedance

I must comment on the Impedance Bridge in Circuit Notebook on page 70 of the March issue. I realise that this is not your circuit but one look at the actual bridge circuit shows that it can only be used for resistance measurements (much simpler to do with an ohmmeter). If the unknown is in any way reactive, the bridge will not balance, or be correct.

For instance, if the unknown is a pure reactance of half the value of the multiplier (ie, an impedance ratio of 2:1), the minimum balance reading (which will be very broad and some 40% of the input voltage) will occur at a 4:1 ratio of the range switch.

As is well-known, impedance bridges must have a compensating reactive component in one of the branches. Even for resistance measurements there is a problem as, with the values shown, the maximum resistance that can be measured is 10kΩ! And of course, no need for choice of frequency. Sorry to spoil the effort.

Charles Borger,
Pascoe Vale, Vic.

Old inverters had lots of interference

In the February 2008 issue, Rodney Champness had an interesting article on old inverters. I grew up on a property in northern NSW with a 32V lighting plant. The important thing to remember about these installations is that they were just that: "lighting plants".

Owners often forced them to do more than just illuminate, eg, operate power tools, etc. Most could not oblige unless you ran the generator as you worked.

We had one of the little Ferris inverters as illustrated in the article. Having a 33kV line running right past our home, we lived in hope of "Town Power" and so had some small 240VAC appliances. The inverter was bought to operate 240VAC electric razors and a battery/mains portable radio. We soon found the interference Mr Champness mentioned.

On enquiry to Ferris we were told that these inverters were not intended to operate radios. Their attitude seemed to be that if one wished to use radios, it would be better to buy an inverter or genemotor that operated at 50Hz. These were available but were very expensive and inefficient.

Of course, at a vibrator frequency of 100Hz, the rather rudimentary power supply filtering in battery/mains radio sets would not have been very effective. But like Mr Champness, I think that the RF filtering could have been better.

Bruce Bowman,
Ainslie, ACT.

Furthermore, how about a demodulator probe for tracking a video signal through the IF sections of a TV set and a piezoelectric clamp that attaches to the injector pipe of older diesel engines to fire a timing light?

Geoff Coppa,
Elanora, Qld.

Circuit Notebook: a few observations

I have a couple of minor observations in respect of two items published in the Circuit Notebook section of SILICON CHIP for March 2008:

(1) The PC cooling fan driver on page 71 has no hysteresis. I think that the fan could hunt around the set-point whenever the +5V rail fluctuates, as it does during variations in CPU load.

(2) The alternator controller on page 68 suffers from two potential problems. The first is that the battery will discharge into the field winding at a maximum rate of ~4A if the motor stops for any reason. To prevent this, I propose that the field section be powered from the alternator's exciter diodes. The initial self-excitation current could be provided by a momentary start switch as in this example at:

http://www.users.on.net/~fzabkar/alt-reg.JPG

The second problem is that a flat battery will be subject to the full output of the alternator which could be 40A or more. I propose current limiting the output as in the previous example (suitably adapted for a high-side field winding).

Franc Zabkar,
Barrack Heights, NSW.

PC boards still use Imperial measurements

I read with a touch of amusement some of the readers' comments about being aghast at the magazine expressing some parameters in the old Imperial units and not in current trendy metric.

Domestic TV sets are expressed in "cm" (diagonal screen size) but an odd thing is that if you take the back cover off the TV set, the actual size of the TV monitor may have, embedded in raised glass (as poured from the factory), the size expressed in inches.

All computer monitors are proudly in inches and of course, 99.99% of all integrated circuits have 0.1-inch pin spacing.

Industrial electronics remains in Imperial, as does aviation which still uses feet above sea level (and pounds of fuel). The Navy use fathoms below the keel and I note that the Bathurst 500 (or whatever) motor race now refers to pounds of fuel and the competitors are not permitted to use litres any more.

A large circuit board company here

Atmel's AVR, from JED in Australia

JED has designed a range of single board computers and modules as a way of using the AVR without SMT board design

The AVR570 module (above) is a way of using an ATmega128 CPU on a user base board without having to lay out the intricate, surface-mounted surrounds of the CPU, and then having to manufacture your board on an SMT robot line. Instead you simply layout a square for four 0.1" spaced socket strips and plug in our pre-tested module. The module has the crystal, resetter, AVR-ISP programming header (and an optional JTAG ICE pad), as well as programming signal switching. For a little extra, we load a DS1305 RTC, crystal and Li battery underneath, which uses SPI and port G.

See JED's www site for a datasheet.

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Mailbag: continued

in Sydney had to close not long ago because they accepted a contract for a large order from a European Telco with all dimensions of the circuit board expressed in metric, with the result that their CNC drilling machines could not drill the boards within the contract time, due to the slowness of a 0.1mm XY axis movement (rather than the normal 25-thou hop, step and jump). 99.99% of all CAD-designed circuit boards are SI'd in Imperial not metric.

So do not be so quick to discard the Imperial measurements when there is really nothing equivalent in metric.

Bob Barnes,
RCS Radio Pty Ltd,
Chester Hill, NSW.

Hardware still comes in Imperial sizes

I was bemused by the gripes of your correspondents, T. Robinson and Ray Smith, regarding the triviality of a few Imperial measurements in your February 2008 issue. Mr Robinson, in particular, was rather childish in my opinion, by threatening to stop buying the magazine if he sees Imperial references. I bet he wouldn't!

Personally, I find "litres per hundred kilometres" to be useless. We buy fuel by the litre, so why not a more useful "kilometres per litre"? I shouldn't have to fool around dividing figures.

Mr Robinson asks who still uses Imperial units. Bunnings hardware stores are full of them! Buy a length of plywood and you can get 1800mm. Why not 1.5 or 2 metres? Because 1800mm is approximately 6 feet. And it used to be 1840mm incidentally, which is almost precisely 6 feet.

Or you can buy 2400mm (rather than the more logical 2.5 metres) which is the old 8-foot length. Better yet, buy it by the lineal metre, which is 3.66 metres or dare I say it, exactly 12 feet; an astonishing coincidence!

Having a Stratco catalog in front of me, I see roofing sheets with a width of 762mm – down to a measly two millimetres? The weird thing is that 762mm is exactly 30 inches or 2.5 feet! Wall siding at 1220mm is exactly 4 feet. Why are ladders 1.8m or 2.4m instead of 2m or 2.5m? Because they used to be 6 feet or 8 feet and basically, they still are! There are lots of odd metric sizes with some equalling precise Imperial equivalents, and the rest being near as hardly matters. We still buy Imperial sized items; they just give us metric equivalent dimensions.

Mr Smith could go to an auto parts store where he can buy a 2000 lb winch or view many other products having Imperial references – not equivalents but delineations. Read a car magazine or watch Top Gear and it's nearly all MPG, cubic inches and foot-pounds of torque. Mr. Smith should also check the diameter of his car's wheels! And might I add, it wasn't all that long ago that TV screens were still quoted in inches, with metrics more of an addendum. Many rulers and tape measures are still marked for both systems and I expect forever will be.

I love metrics. I'd much rather measure down to the millimetre than 13/64ths any day. It is so beautifully simple: a litre of water weighs one kilogram and one thousand of them will fit into one cubic metre and weigh one tonne. And there is the simplicity of the millimetre and its decadic multiples. But nobody should be so blind as to think that the Imperial system is nowhere to be found. Look around, it's everywhere, and it won't go away any time soon.

Paul Carson,
Westmead, NSW.

Interesting circuit doesn't work

I had occasion to build an expanded scale voltmeter recently. I remembered you had already published a very clever version of this, in November 2006, on page 7. This was a reprint from the "Circuit Notebook" June 1995, which I didn't have.

I built it in about 10 minutes and it didn't work! I took some measurements and pondered for a while; it's a bit of a brain-teaser. The problem is that the 7805/7905 devices are designed to source current to the load, and in this case the current is flowing the other way back into both the regulators. This causes the regulation to fail and the output terminal voltage to rise

Microcontroller articles are appreciated

As a regular purchaser of SILICON CHIP, I am responding to your February 2008 editorial where you ask for comments re future articles. I am a farmer in East Gippsland, Victoria. I expect that I would be classed as something of an experimenter in electronics but I do take that further to a point where I build helpful and reliable devices to assist around our home and our farm.

The trend towards microcontrollers: I really appreciate these articles, so keep them coming. It would be a retrograde step for you to ignore their existence and to replace their function with complicated circuitry. One uses an 8-pin 555 timer without a second thought so why single out, say, the 8-pin PICAXE or PIC as being too complicated?

If you set out to ignore them, you might as well close the book on solid-state and go back to having everything operating with thermionic valves. I consider that PICs are incredibly useful and foresee utilising them in various projects in the years to come.

However, I am continually surprised at how many people in the electronics business know almost nothing about the PIC programmers. And I have to admit, were it not for Stan Swan's series of easy-to-read and understand articles on them, I would have had a lot of difficulty in coming to terms with them.

Even with his articles, I was sure that I was going to seriously damage my computer with the serial port link to the device but that didn't happen. The BASIC language they use is not hard; in fact quite fascinating to create, to program into the device and to see whether it does what you want.

In looking for a direction for the future, I think that you should, no, you must publish very elementary projects like Stan's on a regular basis. There are a lot of people to be brought into the PIC fold and the more complicated projects will not entice them into it.

Emphasis on electronic projects as against articles about new developments: I see your magazine as a constructional one and that your present approach is the best. I recall ceasing buying *Electronics Australia* because it had too much on new developments and nowhere near enough comparatively simple constructional projects.

Instructional detail: if one decides to undertake a particular project, you just cannot have enough detail. Your writers do an excellent job and it would be a shame to see that reduced in any way. The consequence of too brief a description is failure of the project.

Internet: I live in an area where rural telephone wires have made ground access to the internet pretty much out of the question. Our only solution would lie with satellite coverage but the cost has been a problem for us. So, with no access, when an article suggests that part of the project information, say for example, a PIC program, should be obtained via the internet, we are in trouble.

Still, I expect that we are the exception and there will be an ever-increasing reliance upon it for such references. Perhaps you could give some consideration to those folk who are for whatever reason, without internet access.

Keith Traill,
Buchan, Vic.

Comment: we can make software available on CD-ROM for $9.50 including postage.

(with respect to its GND pin).

The 7905 was much worse than the 7805. With only 1mA flowing backwards into its output pin, the voltage rises to over 6V. I tried a number of regulators from different manufacturers but they were all the same.

To explain the problem, if we assume 12V is applied to the input, the output pin of the 7905 will be sitting at +7V (ie 12V-5V) with respect to the input minus. This +7V has a current path via the meter to the 5V output of the 7805, thus tending to pull the 7805 to a voltage above 5V. The same happens to the other regulator.

In order to fix it, you need to ensure current is always flowing out of each

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Mailbag: continued

regulator. This requires a load resistor from each output pin to the respective GND pin. I would suggest that, to keep it stable, about five times the current should flow via this resistor, ie, 5mA through the resistor and 1mA through the meter.

I am surprised that Wal Douglas claims to have used it successfully for years.

Bruce Boardman,
Telstra – Wireless Engineering & Operations,
Sydney, NSW.

Comment: well you have uncovered a mess. We did not spot the problem in 1995 and we didn't spot it again in 2006!

Comment on Prius battery life

I can't believe you published Gorton Drennan's letter without a warning about its accuracy. His assertion that the Prius' battery has to be periodically replaced is not true. Toyota claims the battery will last the life of the vehicle. They achieve this by ensuring the battery is never fully charged or discharged.

Mr Drennan has confused the expression "limited capacity" with "limited life". The limited capacity (4Ah) and extra weight of the Prius means that when it is used for any purpose other than city driving, it will not achieve better mileage than many conventional petrol vehicles.

Paul Smith,
Port Macquarie, NSW.

Comment: in fact, the battery does not last forever. We recently had a correspondent who purchased a grey-market import (ex-Japan) 1999 Prius in which the battery has failed. Toyota apparently will not help because the car was not purchased from a Toyota dealer.

Non-metric standards

I was about 10 when we went metric, so became conversant in both metric and Imperial systems. I became familiar with SI units through physics and can happily work in several different number bases.

However, I have never been able to get familiar with kiloparsecs per 100 litres (or whatever) or hecta/megapascals. MPG and PSI still hold a lot of meaning to me, as well as for a large number of other people. Pray you never need to work with old English equipment, when it seemed a new thread was invented for every application!

If seeing MPG on a magazine cover is so distressing to T. Robinson, I hope the editorial staff at SILICON CHIP never show a valve project on the cover again. Presumably, medical assistance would be required!

Brett Cupitt,
Ashfield, NSW.

Comment: you should realise that the metric thought police will be around to your place shortly.

DDS VFO project feedback

I have recently acquired an RCA 89P WW2 (1942/3 build) 2MHz - 20MHz AM crystal-controlled transmitter.

This was used on WW2 warships and was built like a rock, weighing in at a shade under 350kg. This is a long-term restoration project and part of the idea was to convert the crystal oscillator to a VFO.

The DDS VFO article in the March 2008 issue was exactly what I was looking for, so I have embarked on acquiring the parts. The display interested me as I have a few other projects that could use this approach, so I did a search using a popular search engine.

I read around 30 or 40 hits, finding prices ranging from $9 to $61. The $61 was in the first few hits, the $9 in one of the ones much further down. (Tip: when using a search engine, look beyond the first page of results, especially if you want to find the good prices.)

I was pleased to find an Australian supplier of the display (Peakhour at **www.peakhour.com.au**). I ordered a few for the various projects, paid online and they were delivered in two working days. One of the units was damaged in transit and I emailed Peakhour with a photo and they dispatched a new unit on the same day. Ah . . . customer service as it used to be still exists.

Matt Howard,
Melbourne, Vic.

Video on soldering SMDs

Following your article on soldering SMDs in the March 2008 issue, there is an excellent video on this topic at **http://www.curiousinventor.com/guides/Surface_Mount_Soldering/101**

Robert Ellis,
South Oakleigh, Vic.

Comment: thanks for the link although we have to say that we would rather hear the Americans refer to solder as "solder" instead of "sodder"!

Watermark logos are useful

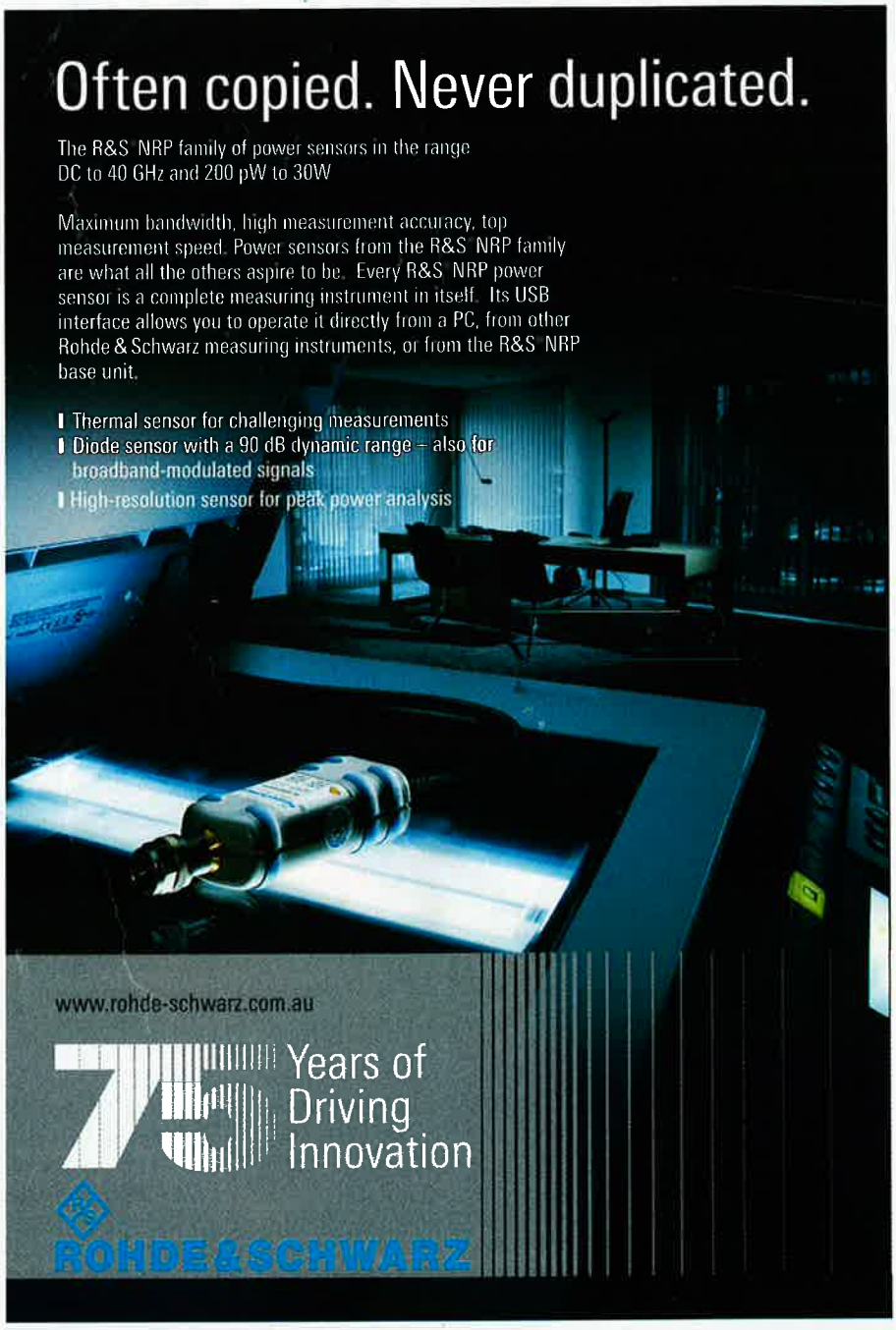
On page 4 of Mailbag in the April 2008 issue, the writer is bothered by television stations identifying their transmission. In fact, I actually find this handy.

Very few modern television sets have channel identification numbers on the front panel. The last TV I owned which showed which channel had been tuned was a 1998 Philips. Newer TVs need a press of the remote control to reveal the station you're on whereas the watermark allows me to see the channel at a glance.

I never find the logos intrusive, as they are "translucent". One can still see the picture behind it. As for sticking a grey paper over the watermark, what does that achieve – only a worse distraction?

The watermark is handy when the program memory location numbers don't equal the channel numbers. For example, my mother has been in hospital three times in the last few months. The TVs there don't display actual channels, only program memory numbers. When I subscribed to cable TV, watermarks were used frequently – including when viewing a recorded program; you knew where you'd recorded it very easily.

P. Smith,
Albert Park, Vic. SC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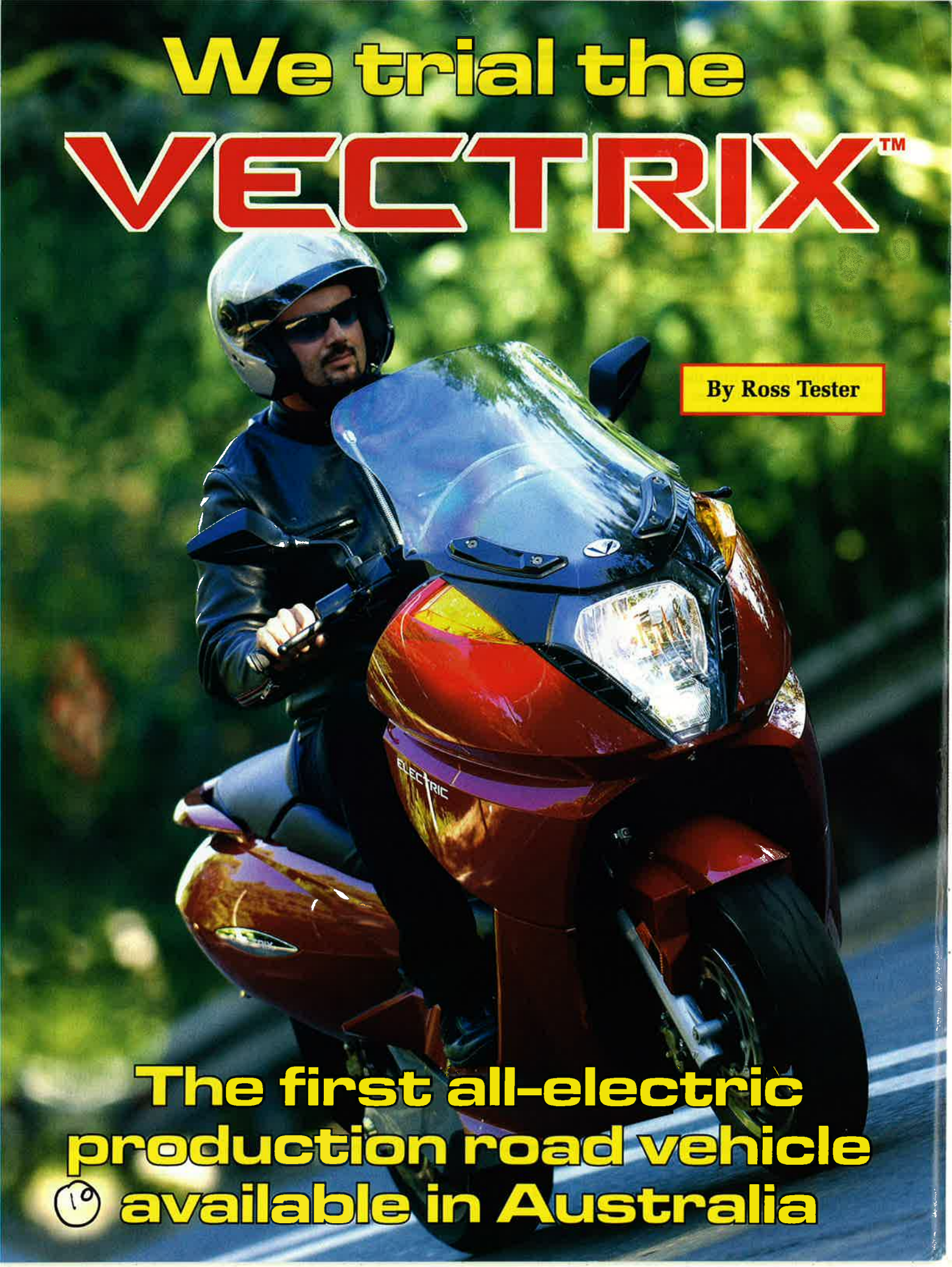
By Ross Tester



The first all-electric production road vehicle available in Australia

Why would SILICON CHIP want to review a motorbike? Aaahh, this is no ordinary motorbike!

As far as we know, the Vectrix Electric Motor Scooter is the first *fully-battery-powered*, road-registered production vehicle of any description on sale to the public in Australia. That is reason enough in itself.

And with all the talk about saving energy, CO_2 emissions and carbon footprints, we gladly accepted the offer of a week's hands-on trial.

We were interested in the Vectrix on two levels – first, how the electric bike compared to its petrol-powered equivalents, ie, how successful was the transition from traditional power to electric power and second (and more importantly to us as a technology magazine) the inner workings of the bike. What had Vectrix done where many others had tried but failed?

Being the only holder of a motorcycle rider's licence around here, yours truly was elected to evaluate it.

One difficulty, being based on Sydney's northern beaches, was that it had to be picked up from the western suburbs. Not being a regular motorbike rider in city traffic, I wasn't at all confident about mixing it with 50km+ of Sydney roads and freeways.

So I fronted the distributor's factory with a large box trailer, loaded up the very heavy Vectrix (a very close fit!), ti ed it on securely and brought it back to the relative safety of the back streets of Brookvale.

I'll have more to say on the street tests shortly. Suffice to say that I also co-opted the services of some experienced (ie, every day) riders to share their opinions and experiences.

Just to re-emphasise: the Vectrix is a fully legal, road-registerable, battery-powered bike. As such, it requires that the rider have both a motor cycle rider's licence and motor cycle helmet to use on Australian roads.

A close-up look at the Vectrix

They say first impressions count – if you didn't know it was an electric bike (and failed to read that huge "electric" logo down the side!), you might think it was just another fairly large motorbike.

But you'd be wrong. Vectrix insist it's a "MAXI Scooter" but we think they are underplaying their hand; damning it with faint praise, if you will.

Vectrix aren't an organisation to hide their light under a bushell. You can't fail to *see* that the bike is electric-powered, even if you can't *hear* it!

The definition of a motor scooter, as far as we can tell, is "a light motor cycle with small wheels". Well, light it ain't, neither are its wheels particularly small at 14-inch and 13-inch (front and rear respectively).

Fair-dinkum "bikes" also have a foot-controlled lever to select gears and, because the clutch lever is mounted on the handlebars, another foot-controlled lever for brakes. The Vectrix has neither of these because it doesn't have a clutch. Both brakes are handlebar mounted, similar to a pushbike.

So it's not exactly a step-through; neither do you have a big fuel tank and throbbing motor between your legs. So, therefore, it's somewhere in between a scooter and a bike.

However, it is fairly large. And it's a lot heavier than most bikes ridden by average riders: the Vectrix weighs in at about 210kg (that's as heavy as some superbikes). A significant proportion of that 210kg is its NiMH batteries. The bike itself features a lightweight, heavy-duty aluminium frame (as shown in our exploded diagrams).

The batteries, all 110 of them, sit low in the bike to assist its centre of gravity. Even so, I'd hate to drop this bike because it would be a pain to get back up*.

This X-ray view of the Vectrix shows the batteries (red) and the charger (orange). The batteries are housed in a heavy fibreglass "safety cell" – just in case.

VECTRIX SPECIFICATIONS

PERFORMANCE	
Maximum Speed	100km/h
Acceleration	0-80km/h in 6.8s
	0-50km/h in 3.6s
Range	110km @ 40km/h
COMPONENTS	
Braking	Front and rear Brembo disc brakes
Tyres	Front: Pirelli GTS23 120/70-14
	Rear: Pirelli GTS24 140/60-13
	Fork: Marsocchi telescopic fork
Suspension	Sachs twin shocks
Frame	Lightweight aluminium
DAaRT™	Patented multi-function throttle provides regenerative braking and slow-speed reverse
BATTERY	
Type	Nickel Metal Hydride (NiMH)
Capacity	3.7kWh
Voltage	125V
Maximum Current	275A
Discharge Cycles	1700
Estimated life	10 years or 80,000km
Charger	1.5kW on-board, 110-240V AC
Recharge time	2 hours (80%)
	5 hours (100%)
MOTOR & GEARBOX	
Motor type	Brushless DC, radial air gap
Power	20.2kW peak
	7kW continuous
Torque	65Nm maximum
	22Nm maximum continuous
Gearbox	Coaxial integrated rear-wheel mounted planetary gear drive
ELECTRONICS	
Controller	DSP & IGBT all-digital electronic control and motor drive system
Instrumentation	One central analog display and two side LCDs, showing speed, odometer, battery charge, estimated range and system status
Communication	Controller Area Network (CAN)
	Systems diagnostic and communication via laptop interface
DIMENSIONS	
Weight	210kg
Wheelbase	1525mm
Seat Height	770mm
Wheels	Front 14-inch, Rear 13-inch
Storage Capacity	Under-seat – 40l (1 full-face helmet)
	Glove compartment – 6l
	Top case – up to 47l
Carrying capacity	2 people (rider and passenger)
OTHER	
Warranty	24 months (+24 with Plug&Go)
Emissions	Polluting – Zero
	CO_2 – Zero
	Acoustic – negligible

The battery pack is rated at 125V, 30Ah (3.7kWh) with the cells arranged in series to get the required output voltage.

The cells are arranged in 3 levels x 2 rows with six temperature sensors and two voltage sensors constantly monitoring them. This occurs even when the bike is not being ridden, with fans used to keep the temperature down.

As we went to press, Melbourne was having an autumn heatwave (40°C days) and on the bikes in use down there, the fans were doing overtime!

High temperatures limit the battery's ability to supply peak power and also interfere with the cooling during the charging process.

Starting

The Vectrix features an inbuilt anti-theft starting procedure (starting is hardly the right word!). Unless you have the "GO" symbol on the instrument cluster, it won't. Go, that is!

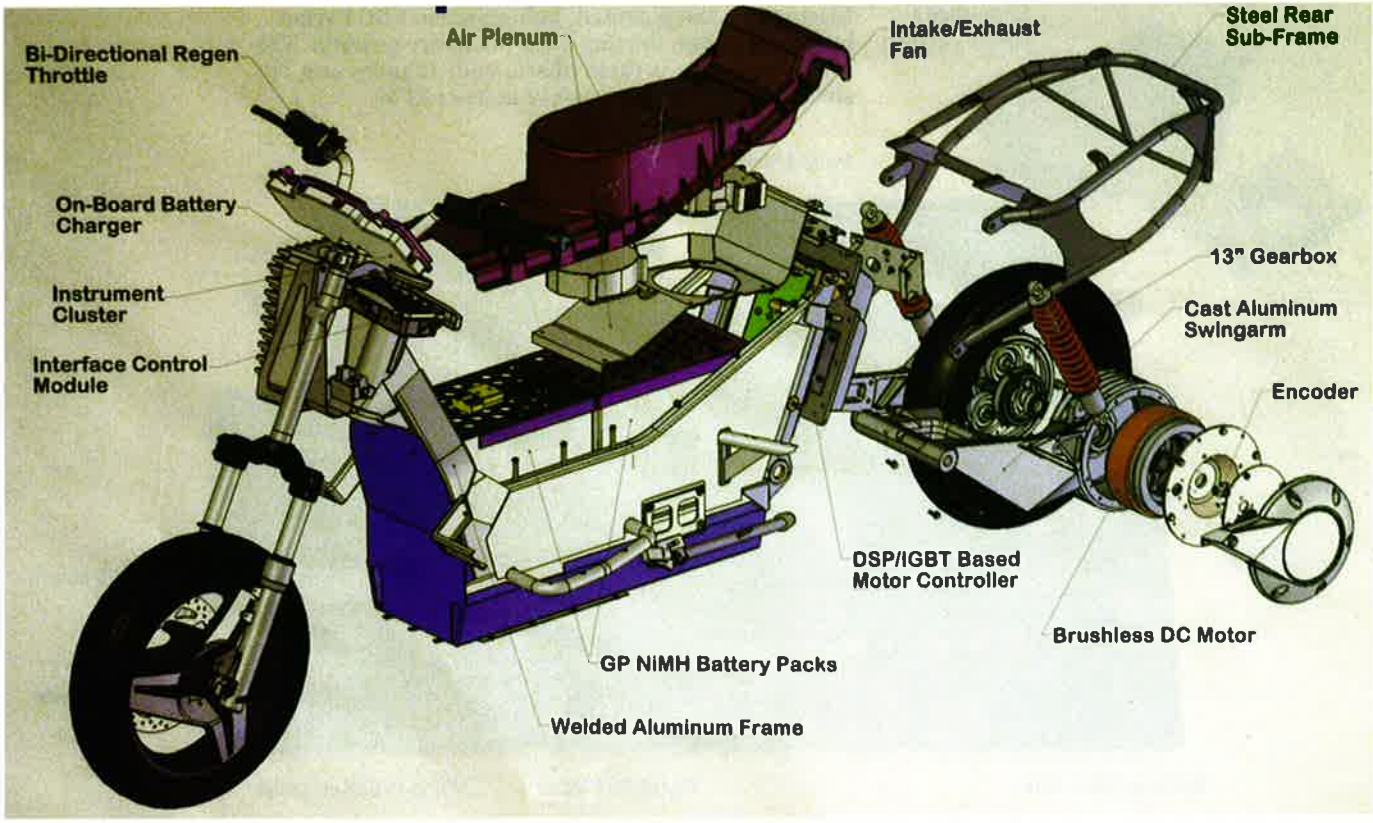
To get it there, you need to turn the key to the appropriate position, wait until the on-board computer has cycled through its self-testing procedure, then squeeze the two brake handles in the right order.

OK, so it's not much of a security feature but unless you know about it, you won't be riding the Vectrix anywhere. Needless to say, I forgot it when I first tried to ride the bike! Putting the kickstand down automatically disables the bike and you must go through the brake handle squeeze procedure again.

Charging

The Vectrix has a built-in 1.5kW 240V mains charger (it's actually under the handlebars). All you need to do is release the luggage container under the seat (again with the main key),

It might look like a conventional bike throttle. But turning it backwards selects slow reverse and/or braking regeneration.



take out the mains lead and plug it in to any standard power point.

The on-board computer goes through a rather (visually) spectacular self-check routine (especially pretty at night!) then proceeds to fast-charge the battery pack at the appropriate rate. 80% charge is achieved in two hours but there is no problem in leaving the bike charging overnight – the computer ensures the batteries can't be cooked by overcharging.

Charging is a four-stage process. Initially, the computer does a pre-check to ensure all is well with the pack.

It then undertakes a "conditioning" charge of around 3-4A. The third stage is the main charge, which is a constant-current charge of 10-12A, the precise rate determined by the computer from the battery's initial charge level and also from the condition of the battery cells themselves.

Finally, it enters a transition stage which, at 1-3A, can be regarded as a top-up. The inbuilt fans can start at any time during the charging process and will generally still be cooling the cells down next morning, even though the charge itself may have ceased some time before.

At current (Sydney) standard electricity rates (12.87c/kWh), it takes roughly 50c worth of power to fully charge the Vectrix. And if you have off-peak electric (5.39c/kWh), you could have a new GPO fitted to that circuit and the power charge would then reduce to about 21c.

In a PowerSmart home, a similar reduction would happen automatically if you charged in the off-peak period (ie, 5.61c/kWh between 10pm and 7am).

The bike also has an "accessory" socket for charging such things as mobile phones.

The motor

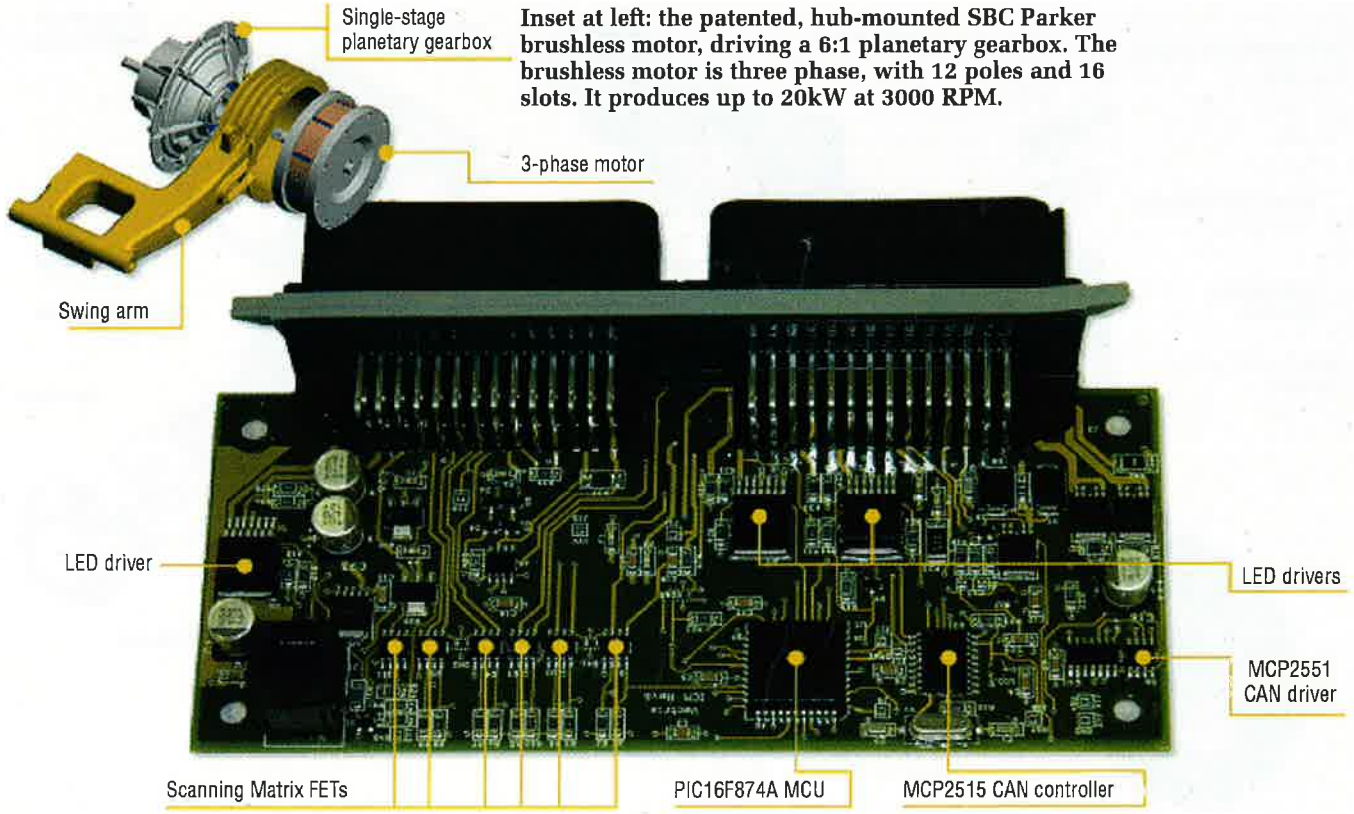
The 20kW (peak) motor is built into the rear wheel hub and is directly connected via the planetary gearbox. There is no chain or belt drive – often the bane of petrol-powered bikes if only because of the frequent maintenance required.

The motor is consistently described in Vectrix literature and websites as a "brushless DC" type which we believe is a misleading term. It's a common error made where the motor supply is battery (DC). But we believe it's misleading to describe any motor as a DC type when, as in this case, the motor is a variable-frequency, 12-pole 3-phase AC type.

Speed control of this type of motor is achieved by varying the frequency via the DSP & IGBT electronic controller. For those who are interested, we explain this in more detail in the separate panel at the end of this feature.

1. Driver information LCD
2. Anti-theft indicator
3. Low battery voltage indicator
4. Battery level indicator
5. Vehicle power switch
6. Dual function throttle
7. Speedometer
8. Estimated range
9. Key ("ignition") switch
10. Turn signal
11. Ready/Go indicator

The instrument cluster is fairly typical bike, except for that big "GO" symbol on the left LCD display and the battery level indicator on the right.



Inset at left: the patented, hub-mounted SBC Parker brushless motor, driving a 6:1 planetary gearbox. The brushless motor is three phase, with 12 poles and 16 slots. It produces up to 20kW at 3000 RPM.

The heart of the Vectrix – the Interface Control Module or ICM, which governs all operational aspects of the Vectrix, everything from the turn indicators to throttle settings and regenerative braking control. Microchip PIC microcontrollers are used throughout.

The motor is governed so that it cannot exceed 100km/h. With a maximum motor speed of 3000 RPM, this means that the controller runs up to 300Hz to achieve the 0-100km/h speed range.

It has a reverse gear!

When I picked up the Vectrix, Tony, the Sydney agent carefully explained the starting procedure, throttle control and brakes – and their use. For the most part, the handgrip-based control is typical of any motor cycle throttle control – turn it towards you and the bike accelerates, all the way to maximum speed (there is no clutch nor user-controlled gearbox).

But if you turn the throttle control in the opposite direction, the motor is put into reverse – from any speed.

Quality Brembo brakes are fitted – but you'll seldom use them!

That might sound dangerous but its not – in fact, it's a bona-fide way to control this bike. It was, in fact, one of the significant design features of the bike and is patented.

As you might imagine, a reverse gear is very handy for slow-speed manoeuvring and parking but that is not its main purpose. Putting the motor into reverse while travelling forward introduces regenerative braking, not only slowing the bike but putting braking energy (which would normally be wasted as heat) back into the battery.

The Vectrix specs claim up to 12% energy recovery. That mightn't sound like much but if you're approaching the 80km limit and you're 10km from home, it could be a lifesaver!

Tony further explained that for the first half hour or so, I would be using the front and rear disc brakes (Brembos) just like a normal bike. "But as soon as you get used to using reverse, you'll probably never touch the brake levers again."

And he was right! It became almost second nature to reverse the throttle any time I needed to slow down. And it was so smooth.

The only time I needed the handbrakes was when I took the Vectrix down my long, "S"-shaped, 1-in-3 driveway and found the reverse gear couldn't hold it. Incidentally, going back up again the Vectrix was still accelerating nicely at the top!

Not enough noise?

We mentioned before the noise (or lack thereof) of the Vectrix. Just a bit of gearbox and engine whine on acceleration and quite quiet as you drive along at local street speeds.

And believe it or not, that's a down-side. Pedestrians don't hear you coming as they would a bike or a car. During the few days of riding,

Look mum – no CO_2 (well, not from the bike, at least. Maybe a tad from the power station?). Vectrix certainly haven't failed to target the "green" market.

I had to hit the anchors several times as completely oblivious pedestrians (many busily chatting away on mobile phones) stepped out into my path.

What ever happened to "look right, look left and look right again"?

Fortunately (and probably due to the fact that I was a pretty slow rider), I had the reaction time necessary ***to*** react so no harm was done (except perhaps to my heart rate). But it is certainly something all electric vehicle riders/drivers will have to keep in mind as numbers increase.

Then again, as any bike rider will tell you, the vast majority of pedestrians are idiots, followed closely by the majority of car drivers (particularly Volvo drivers with big ears and hats).

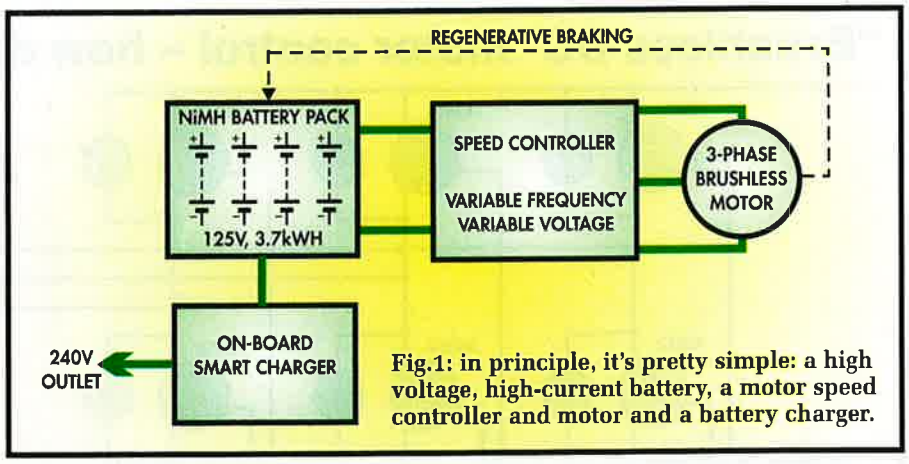


Fig.1: in principle, it's pretty simple: a high voltage, high-current battery, a motor speed controller and motor and a battery charger.

Instrumentation

The instrument cluster has three "dials". Centre is the speedo/odometer, while on the left is the "ready-GO" indicator, clock trip meter and estimated range indication. On the right is a large graphic instantly revealing battery state-of-charge – virtually a fuel gauge.

Above are the indicators for left/right turn, low battery warning, theft protection on/off, high/low beam and service required light.

The left handlebar has the light switch, high/low beam, horn, plus turn signals and cancelling, The right has only the power on/off switch and, of course, the patented throttle control discussed earlier.

Other riders

I gave a couple of long-term motor bike riders the opportunity to take the Vectrix for a run.

One (actually my son-in-law, who features on this month's cover) has a couple of bikes, one not too different in capacity to the Vectrix and another, a superbike, not too different in weight but very different in performance.

His reaction? "Wow!" Of course, it didn't have anything like the acceleration or speed of the big bike but he thought it compared quite well to his 250cc. For him, it had plenty of low-end grunt and continuing acceleration and power.

The reverse gear had him bemused,

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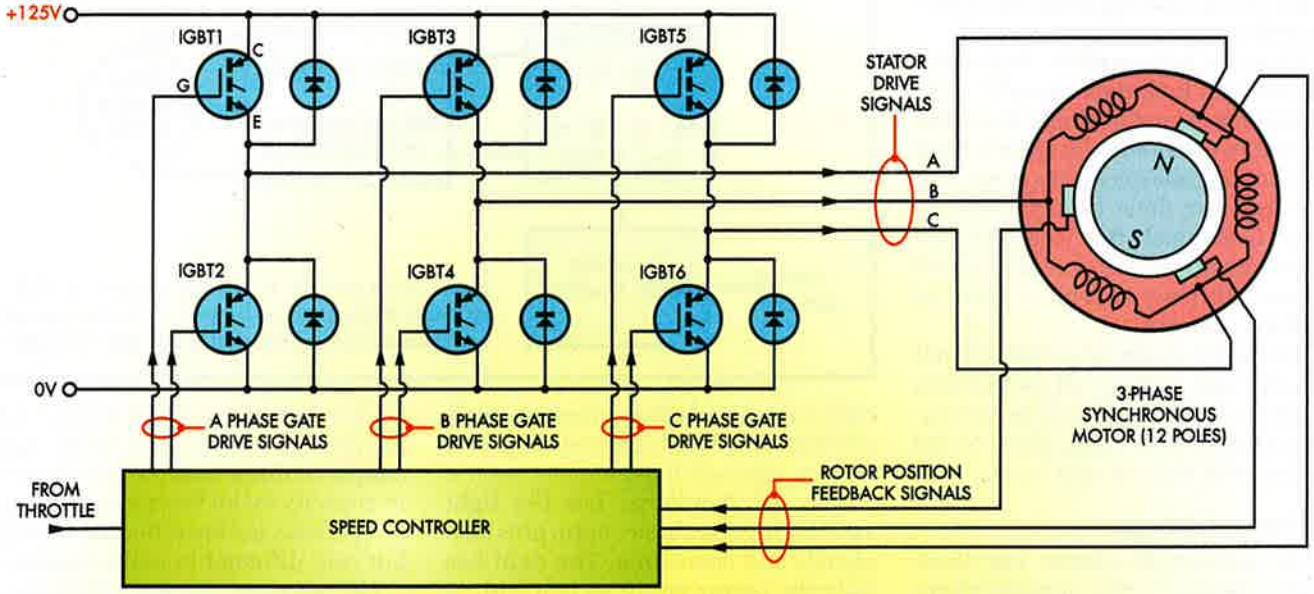
"Brushless DC" motor control – how does it work?



The hub motor used in the Vectrix motorbike is variously described as a "brushless DC" and also as a "12-pole 3-phase" motor which is likely to confuse many readers. In reality, there is no such thing as a brushless DC motor.

All DC motors have brushes and a commutator while brushless DC motors are actually 3-phase motors driven by a 3-phase variable frequency converter.

For power ratings up to about 20kW, as used in the Vectrix, the motor can be regarded as a synchronous motor with permanent magnets providing the rotor field. Larger brushless motors can be regarded as induction motors.

Synchronous motors are always locked to the rotating magnetic field produced by the stator but the rotor may lag the field by a small amount depending on the load.

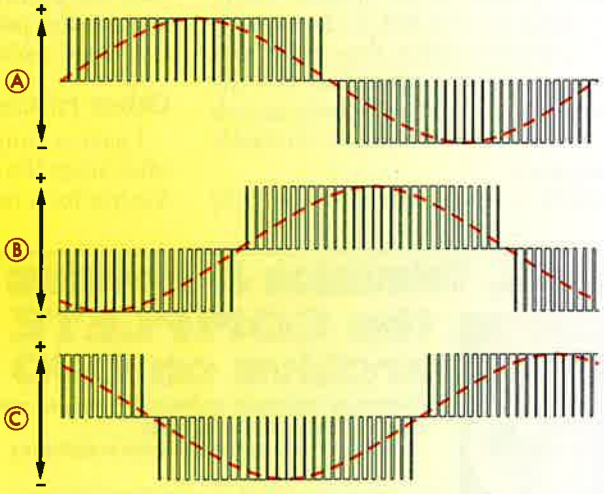
By contrast, induction motors are never locked to the rotating magnetic field and their speed is always less than the synchronous speed. This is measured as "slip" which is typically around 5% at rated load. Such a motor (4-pole) would have a rated speed of 1440 RPM compared to synchronous speed of 1500 RPM.

The circuit above shows the general arrangement of the motor and its controlling electronics. The heart of the circuit uses six Insulated Gate Bipolar Transistors (IGBTs) powered by 125V DC from the NiMH battery pack.

That much we know from the limited information in Vectrix literature. From here on we are speculating on just how it is controlled but the method is typical of brushless DC motors. Nor do we know if the motor is connected in star or delta configuration.

Note that the IGBT symbols shown in the circuit above are not incorrect. They are typically, although not always, shown with arrows for the collector and emitter. Also note that the motor's rotor is shown as having only two poles (N & S) whereas it actually has 12.

The six IGBTs are driven with pulse-width modulation (PWM) signals to provide three sinewave averaged output voltages with 120° phase separation, ie, as for a normal 3-phase motor. The frequency of the outputs is varied between 1Hz and 300Hz, giving a maximum motor speed of 3000 RPM. Furthermore, since the motor's impedance will vary in direct proportion to the frequency,



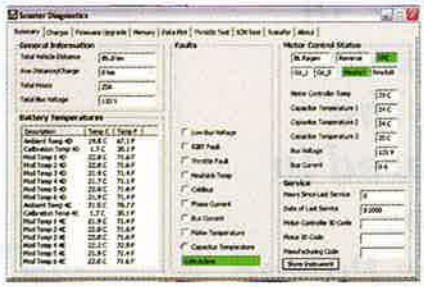
the amplitude of the drive voltage must be reduced as the frequency is lowered.

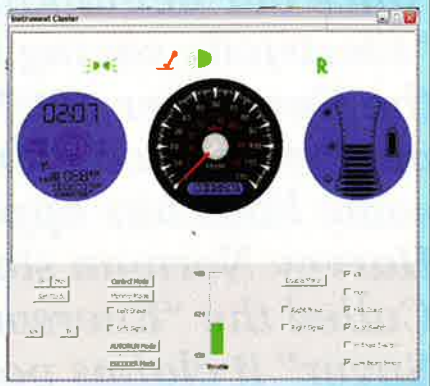
Note that the motor is rated at 7kW continuous but as with many (if not most) 3-phase motors, the peak power output is considerably higher at 20kW. The limitation will be due to power dissipation limits in the windings of the stator and power dissipation in the 3-phase converter. Peak currents from the battery pack can be as high as 275A.

The PWM signals to give the variable sinewave outputs to the motor may be up to 25kHz or higher. The motor responds to the average value of the phase outputs (A, B & C) and ignores the pulse width modulation.

For precise speed control, the stator will include three Hall Effect devices to give rotor position measurement. This will allow the speed controller to vary the phase-lead or phase lag of the rotating magnet field (produced by the stator winding) with respect to the magnetic fields produced by the of the rotor's permanent magnets. With phase lead, the motor will provide power to the wheels via the planetary gearbox. With phase lag, the motor will become an alternator to provide regenerative braking. Alternatively, by changing the direction of the rotating magnetic field in the stator, the motor will drive the bike in reverse. (L.D.S.)

Vectrix Health Check Diagnostics





When you put your Vectrix in for its six-monthly "Health Check" the dealer will use this diagnostic software, via the CAN BUS and accessed through a serial socket inside the glove box, to check that all is A-O-K with the bike, the batteries and everything else!

At that time, the dealer can tweak any parameter and also upload the latest firmware to your bike. As it is a brand new design, revisions will continually take place to make it perform better, adjust charging characteristics, prolong battery life, check operating temperatures and even fix bugs!

In keeping with the very low running cost of the machine, Vectrix expect the dealer Health Check to be quite low in price – in the order of $65 or so .

And no (sorry!), the Health Check diagnostic software will not be available to Vectrix users.

the first time he'd ridden a bike with one. But like me, he found it very easy to get used to and to use instead of the brakes.

His test ride turned out a bit longer than intended, as his F250 truck broke down on the way to our photo shoot location – and he borrowed the Vectrix to ride home and back with tools!

My other bike-riding friend commutes every day on his Triumph. He expressed reservations about the 80km range, until I asked him how far he rode to work and back. "Mona Vale to Chatswood, about 20km each way," he said.

Then the penny dropped – his ride was almost spot on the average bike commute of 40km per day which Vectrix research had shown.

He could ride to work and back – with plenty of reserve if he had to go somewhere else. And if necessary, he could plug the bike in to a power outlet at work and charge (to 80%) in two hours for another 60km or so of range.

When he thought about this, his comment was "They'll sell squillions of these . . ." Now I'm not sure how many squillions there are to the boatload but I'm pretty sure the Australian distributors would love to hear this.

The WOW factor

SILICON CHIP is located in Brookvale, on Sydney's Northern Beaches. As well as being the home of a number of surfboard manufacturers, our street is also an auto alley – plenty of open-to-the-street mechanical and auto-electrical workshops. The Vectrix created quite a stir; the greasies and sparkies pouring out of their buildings, wanting to know all about it.

Believe it or not, one guy even showed me an electric bike *he* had tucked away – a Chinese import that could not pass ADR rules, so it couldn't be registered. He mainly uses it for the grandkids to ride around on his country property.

He couldn't believe that someone had actually released a road-registerable model – "at long last," he said .

My impression

I loved it – on any number of levels. It's easy and fun to ride and being electric, certainly turned heads (if they heard it!).

The technology behind the Vectrix is clearly well thought out and well engineered.

For the commuting or occasional short-trip bike rider, the Vectrix is a clear winner. Because it is electric powered, it offers quite a number of advantages over a petrol-powered bike – not the least of which is low cost of running and service.

It's not the bike you would take to tour Australia – unless you took it in tiny bite-sized chunks and had charging organised wherever you stopped. But then again, it was never intended for this market.

Its other main disadvantage is its cost – at $15,950 plus on-road costs (dealer delivery, registration, CTP – likely to add another grand) it's significantly more expensive than the average bike a commuter might purchase.

But that, to a large extent, is a feature of its "newness" – all leading edge products come at a premium (remember early computers, DVD players, plasmas, etc?). And it's in a similar market position to the Tesla Roadster electric sports car in the USA, now being sold for $US100,000 and they can't make enough!

I would expect the price of the Vectrix to drop as (a) sales volumes increase – with higher volumes come economies of scale. So far, all Vectrix advertising has been word of mouth – and they are starting to sell); and (b) competition comes onto the market.

I've heard a number of reports that many organisations in China are working hard to produce road-registerable electric bikes.

If you're looking for a fun bike to ride to work, uni, etc; don't need long range; like the idea of very low running costs . . . look at the Vectrix.

** Woops. Mea Culpa. As it turned out, I did drop it – would you believe as I loaded it back on the trailer to return it? And yes, it was a real pain to get back up. Sorry, Vectrix!* SC

Contact:
Vectrix Australia
164 Rouse St Port Melbourne 3207
Ph: (03) 9676 9133
Website: www.vectrix.com (US site)

Since our debunking of the "Electricity saving box" in the November 2007 issue, another device along the same lines has appeared in Harvey Norman stores. Called the "Enersonic Power Saver" it claims potential power savings of up to 24%. At $59.00, it is considerably more expensive than the previous device but just like that one, it won't save you a cent on your electricity bills.

Enersonic Power Saver

Sorry . . . it doesn't work either!

By LEO SIMPSON

A number of readers contacted us by phone and email to ask about the "Enersonic Power Saver". This was featured on the Seven Network's "Sunrise" program on March 3rd and is the subject of favourable comment on a number of websites, such as www.gadgetguy.com.au

Those who had seen the Electricity saving box article were curious/concerned/outraged that a similar device would appear so soon after the first had been thoroughly debunked.

We promised to follow it up and checked the Harvey Norman website to find out about the device.

I then went to our nearest store and while the helpful salesman knew about it, they did not yet have stock available. As I left, he remarked that it "worked by cutting the amperage, not voltage". "Hmm, that's interesting", I thought.

The poor sod had no idea...

On the way back to the SILICON CHIP offices, I remembered that an American company devised a power reduction circuit for induction motors during the 1970s. This used a phase-controlled Triac to slightly reduce the voltage to the motor which apparently had the effect of reducing power consumption while not making much of a difference to reliable running of the motor.

In such a device, you cannot reduce the voltage by very much, say no more than 15 or 20%, otherwise the induction motor would refuse to start and be at risk of burnout.

In practice, I think the device did not catch on and its power savings would

have been marginal anyway.

So I wondered whether this new Power Saver could possibly be based on a phase-controlled Triac.

The reason for thinking along these lines was that the promo photos for the Power Saver, in the Harvey Norman catalog, showed it in conjunction with a 2-door refrigerator, a front-loading washing machine and a wide-screen TV (plasma or LCD?). Both the first two appliances would use an induction motor.

But I also noted that the Power Saver is suited to appliances up to 2400W (10A). That would probably rule out use of a Triac inside the plastic case. Why? Because a rule of thumb is that a Triac will dissipate a little over one watt for each amp of current that it controls.

So if the Power Saver used a Triac, its total dissipation when controlling an appliance load of 2400W would be 12W or more – too much inside a plastic case with no ventilation.

So that meant the Power Saver was probably predicated on power factor correction, just like the Electricity saving box. As soon as we obtained a unit, we would be able to confirm that.

The first thing we did when we unpacked the unit was to check the capacitance between the Active and Neutral prongs on the integral 3-pin plug.

Yep, it was 6.11µF; not much different from the 6.2µF capacitor we found in the Electricity saving box. So it is the same product dressed up in a different box.

We could end this report right here and state that these things are a fraud and a total waste of money. That would please people who read our November 2007 article and they could sagely nod their heads but it would leave others none-the-wiser.

So we had better explain.

By the way, we should state that incredibly, at least one person has read the November 2007 article and has not realised that the Electricity Saving Box is a fraud.

Maybe we did not say it strongly enough.

THE ELECTRICITY SAVING BOX DOES NOT SAVE ELECTRICITY. IT IS A FRAUD.

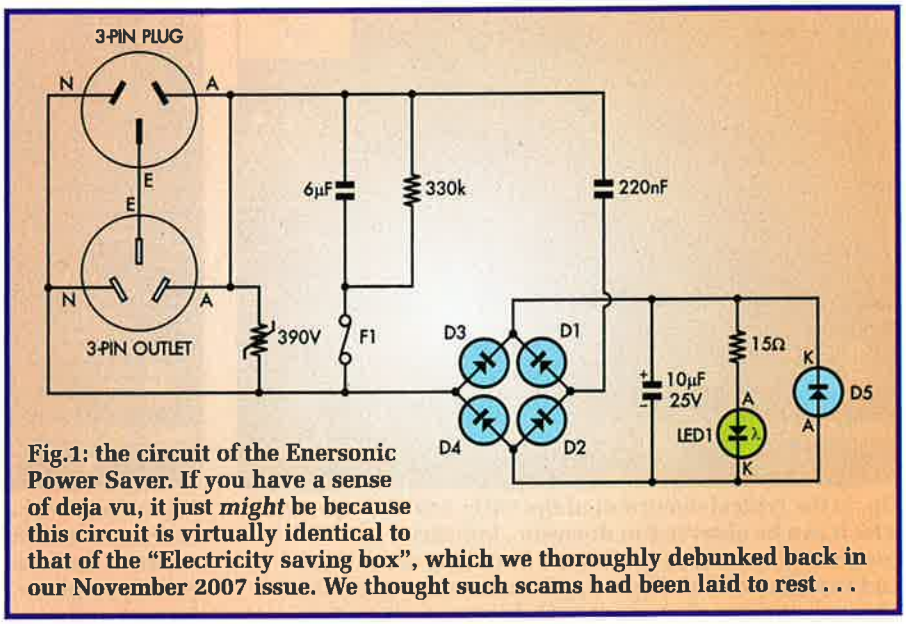


Fig.1: the circuit of the Enersonic Power Saver. If you have a sense of deja vu, it just *might* be because this circuit is virtually identical to that of the "Electricity saving box", which we thoroughly debunked back in our November 2007 issue. We thought such scams had been laid to rest . . .

There, that oughta do it.

In brief, "power factor correction" is a process whereby lagging currents drawn by inductive loads such as fluorescent lights and motors are brought back into phase with the 50Hz sinewave of the voltage waveform.

Such lagging currents (ie, out of phase with the sinewave voltage waveform) are a problem for the electricity supply authorities because they place additional load on the alternators, substation transformers and the distribution system in general.

Power factor correction is very worthwhile in industrial and commercial buildings which have large numbers of fluorescent lights and induction motors. In fact, fluorescent lights installed in commercial and industrial buildings must all have power factor correction capacitors inside the battens.

But here is the rub: fluorescent lights for domestic installations usually do not include power factor correction capacitors because the supply authorities do not regard it as a problem.

Furthermore, your household power meters only measure watt-hours or

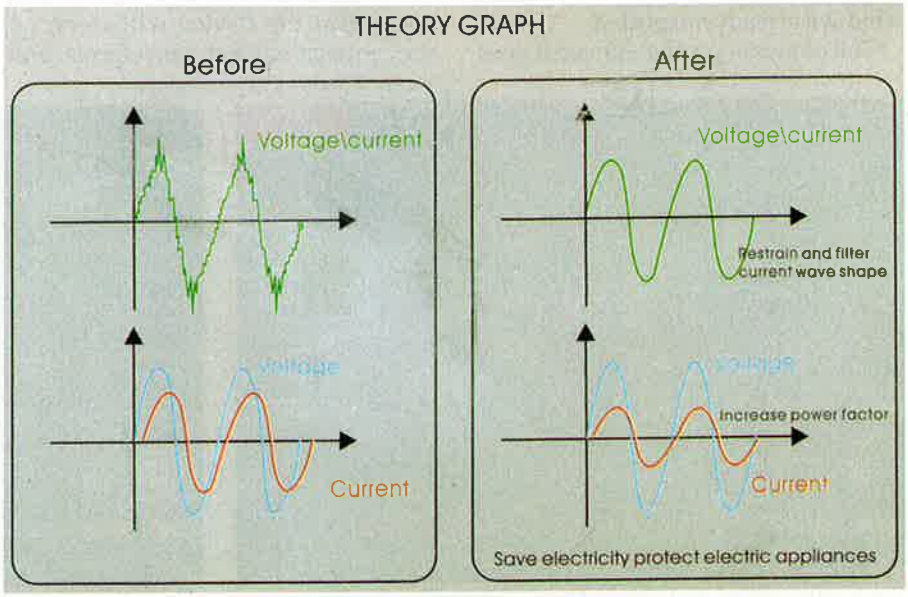


Fig.2: gee, they could be on to something here . . . This diagram comes from the box the Enersonic came in. If this device could turn the green before waveform into the green "after" waveform, it might be useful as a spike suppressor. But it's not – and it sure ain't gonna lower your power bills! The words "naive" and "gullible" spring to mind – but so should the words "consumer protection."

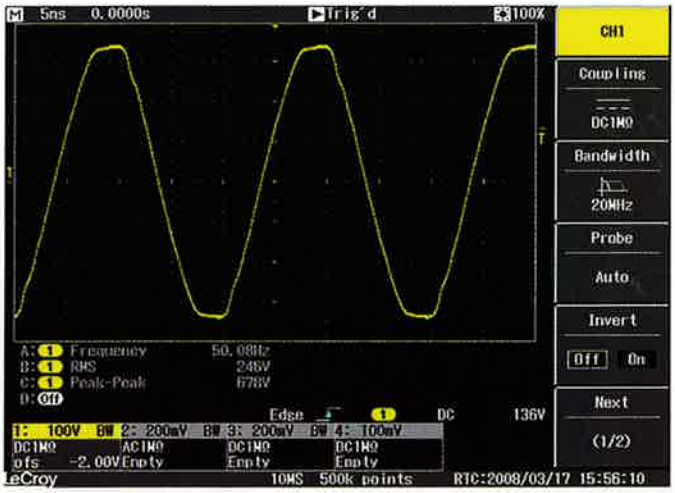


Fig. 3: the typical distortion of the 50Hz 240VAC sinewave which can be observed in domestic, industrial and commercial premises. Notice the flattening of the peaks and troughs and the slight ripple in the sloping sections. This was measured at about 3.3% harmonic distortion.

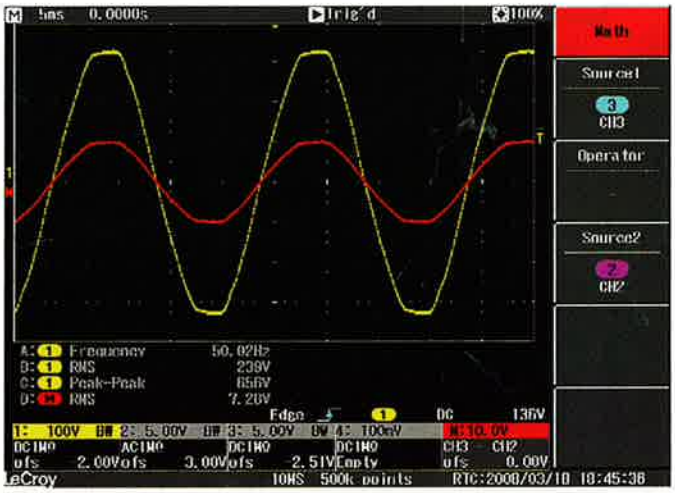


Fig.4: these scope waveforms demonstrate the voltage and current waveforms for a 500W halogen spotlight. This resistive load has the voltage (yellow) and current (red) exactly in phase and the power factor is 1 (or 100%). All heaters and incandescent lamps are resistive loads.

kilowatt-hours. They do not measure "reactive power" (kVAr) which only becomes significant if power factor is a problem.

So even if you use an Enersonic Power Saver to totally correct the power factor in your household installation, there will be no saving in power. Zero! In fact, because the Power Saver has an internal circuit to run its LED indicator, it will actually draw a small amount of additional power. So you will pay more, just to run the Power Saver!

After we had run all the tests on the unit, we pulled it apart to confirm what we already suspected.

The photos show that indeed it does use a capacitor and it is labelled "6µF 450V AC". It also contains a small PC board which has a fuse (why?), a VDR (voltage dependent resistor) and a power supply to light the single LED.

It is almost identical to the circuit of the Electricity saving box discussed in the November 2007 issue. What a coincidence! The details are shown in Fig.1.

Voltage stabilisation

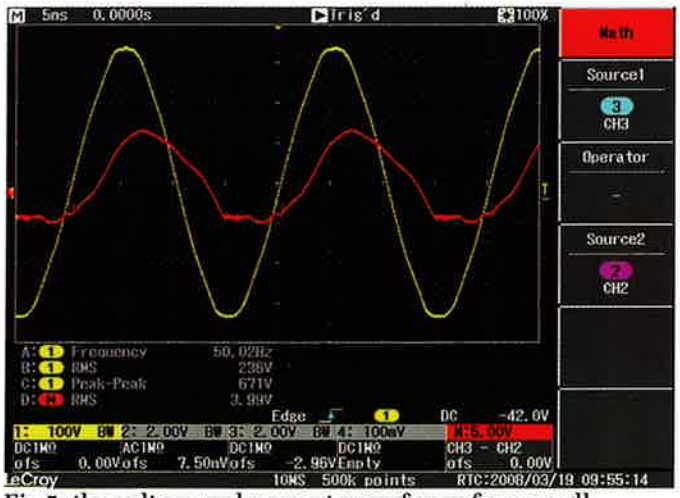
Apart from making outrageous claims about power saving, the makers of the Enersonic Power saver also claim that the device will clean up the voltage/current waveforms and stabilise the voltage.

This is stated in the tiny instruction manual and implied in the waveforms on the packaging (see Fig.2).

In the "Before" diagrams on the left-hand side of Fig.2, you will see a rather ragged looking voltage waveform at top and a set of voltage (blue) and current (red) waveforms at bottom.

Voltage waveforms

In all the years that I have been observing 240VAC 50Hz mains waveforms, I have never seen anything as ragged as in Fig.2. In fact, the power supply authorities do maintain performance standards for harmonic content, because high values of har-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Math
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CH3
Operator
Source2
CH2
A: 1 Frequency 50.02Hz
B: 1 RMS 236V
C: 1 Peak-Peak 671V
D: M RMS 3.99V
Edge 1 DC -42.0V
1: 100V BW 2: 2.00V BW 3: 2.00V BW 4: 100mV M:5.00V
DC1MΩ AC1MΩ DC1MΩ DC1MΩ CH3 - CH2
ofs 0.00V ofs 7.50mV ofs -2.96V Empty ofs 0.00V
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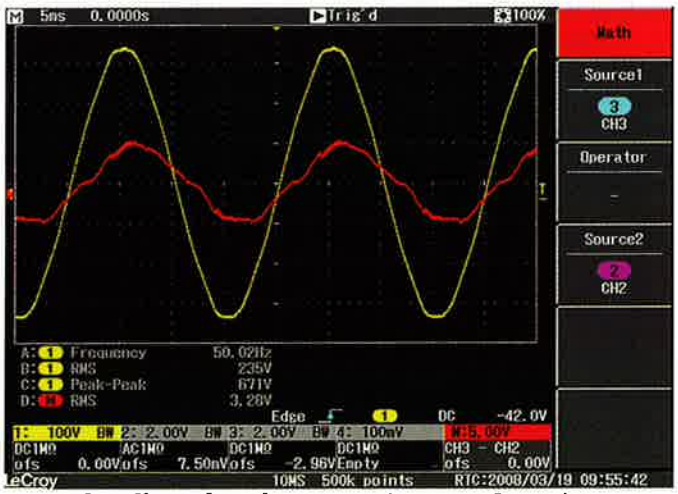
Fig.5: the voltage and current waveforms for a small refrigerator which consumes about 200W when the compressor is running. Notice the phase lag between the voltage (yellow) and the current (red). This phase lag is of no concern to the average consumer and does not cost anything.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B: 1 RMS 235V
C: 1 Peak-Peak 671V
D: M RMS 3.28V
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1: 100V BW 2: 2.00V BW 3: 2.00V BW 4: 100mV M:5.00V
DC1MΩ AC1MΩ DC1MΩ DC1MΩ CH3 - CH2
ofs 0.00V ofs 7.50mV ofs -2.96V Empty ofs 0.00V
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Fig.6: the effect when the Enersonic Power Saver is connected in the circuit, demonstrating that it *does* have an effect on power factor. The current waveform (red) is now more in phase with the voltage waveform (yellow) and is reduced in amplitude. Paradoxically, the power consumption actually increased by about 5W.

monics (ie, harmonic distortion) can cause problems in the distribution network.

That is not to say that distorted mains waveforms do not occur and the scope waveform of Fig.3 is quite typical of what can be observed in any commercial or domestic location. In fact, it was taken at my home on Sydney's northern beaches.

Notice that it is flattened on the peaks and troughs, as well as being not quite smooth as it should be on the sloping sections. In fact, we have the equipment to measure such harmonic distortion but in this case we did not have to go to the trouble of making "safe" connections to make such a measurement.

Instead, we had an Ideal Voltage Performance Monitor (VPM) in for review at the same time.

This instrument monitors voltage, impulses (ie, transient spike voltages), total harmonic distortion (THD) and other parameters.

Typically, when monitoring the 240VAC mains waveform in the SILICON CHIP offices, this gives readings around 1.2–1.3%. However, at the time that the waveform on the scope was recorded, its readings were much higher at around 3.3%.

So we were able to use the Ideal VPM to monitor the mains voltage parameters with and without the Enersonic Power Saver connected and with various loads such as a refrigerator and vacuum cleaner connected.

Guess what? The Power Saver made zero difference to the observed waveforms or the measurements on the VPM.

We expected nothing more, of course, but we had to go through the process.

We also monitored the voltage and current waveforms for a small refrigerator in the SILICON CHIP kitchen, as shown in Fig.3.

In this case there is a phase lag between the voltage waveform (yellow trace) and the current waveform (red trace). This is to be expected with the inductive load presented by the fridge's compressor motor.

We then connected the fridge via the Power Saver and made the measurement again. This showed that the power factor correction capacitor does indeed work, as we would have expected. (See Fig.4).

Notice that the red current trace is not only more in phase with the yellow voltage trace but is also reduced in amplitude. So that's good. But at the same time, we were measuring the power consumption and the difference was not what you would expect.

Checking power consumption and power factor

We had two options to measure power consumption. The first was our own Appliance Energy Meter (SILICON CHIP, July & August 2004) or a much more compact Multi-Function Energy Meter from Jaycar (Cat MS-6115). Interestingly, this latter device will give a reading of the power factor of the load. Bingo!

So we plugged in the fridge via the Jaycar unit. It read the fridge's power consumption at 220W or thereabouts but it tends to drop the longer the compressor runs. And it gave a power factor reading of around 57, which equates to 0.57.

Plugging the Enersonic Power Saver into the dual GPO then changed the power factor reading to around 87 or thereabouts, showing that it was indeed correcting the power factor. But the power consumption reading

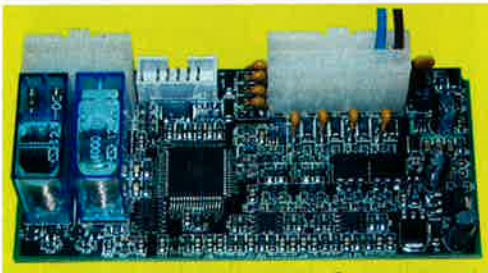
Jaycar's Multi-Function Energy Meter

During the testing of the Enersonic Power Saver we used the Jaycar Energy Meter in helping to assess whether power was being saved (or more being used).

It has a 3-pin socket so the appliance you wish to monitor can be simply plugged into it. It has switches to allow it to display the mains voltage and appliance current, power consumption, power factor, and overload current, mains frequency and the time.

You can enter in your electricity tariff and display the cost of running the appliance over a given length of time. The meter works well but we found the displayed units are very small and difficult to read.

The Multi-Function Energy Meter is available from all Jaycar Electronics stores and website at $39.95 including GST. (Cat MS-6115).



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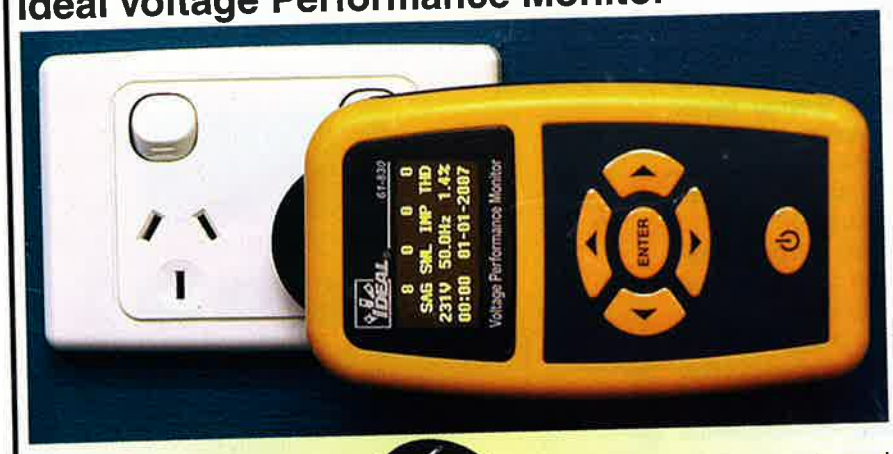
Ideal Voltage Performance Monitor



This compact instrument captures and logs mains-specific voltage parameters that can affect the performance of equipment such as induction motors, sensitive instrumentation, medical equipment and so on.

It reads and displays four parameters: true RMS voltage, impulse voltage (above 450V to 4kV, positive or negative), THD (total harmonic distortion) and mains frequency from 45-65Hz.

In addition, it will display and log the deviation from the nominal voltage (ie, 240V) as a SAG or SWELL (SWL) together with the logged time.

Impulses are displayed as IMP, with the magnitude in kV and duration in microseconds, again with the logged time. THD is displayed as percentage (eg, 1.3%)

Up to 512 events can be logged and subsequently scrolled through with the enter and navigation buttons.

The display is a bright yellow OLED type and it can be inverted just in case the VFM is plugged into a GPO which places it upside down.

Unfortunately, the 2-pin Australian socket adaptor it comes with will normally position the instrument sideways, so you have to crook your head to read the display (see photos above).

That aside, this is powerful instrument for monitoring mains voltage.

For further information, contact Trio Smartcal. Phone 1300 853 407
Fax 1300 853 409
Email: trio@smartcal.com.au

increased. Whoa! That's not right. We didn't believe it.

Repeating the power consumption test with the SILICON CHIP Appliance Energy Meter also showed an increase when the Power Saver was plugged in but in this case it was only a few watts. Nevertheless, rather than giving no change which we expected, there was an increase. I repeated these tests with a small fridge in my home and came up with exactly the same results – an increase in power consumption, not a decrease.

Summary

OK, so where does all that leave us? Our conclusions were:

(1) The Enersonic Power Saver may provide a degree of power factor correction for inductive loads BUT

(2) It will not result in any reduction in real power as measured by any appliance energy meter or the meters in your power box at home. It will probably lead to a small increase.

(3) It does not "clean up" voltage and current waveforms and it does not have any means of doing so.

A few other comments should be made. The Enersonic Power Saver is stated to be "Designed & Engineered in Australia". That may well be true but electrically, it is *very* similar to the Electricity saving box, which was claimed to be the latest technology from Germany.

It also has an Australian Approval Number (NSW 22555). This shows that it complies with Australian electrical standards but that in no way indicates that it will do what it claims.

Enersonic also suggest that "For best results, use 3 to 4 pieces of Power Saver per typical size home". Apart from being poorly expressed, this is a lie! There is no power saving with one device and the power saving with four such devices will be exactly four times zero = zero.

So how do you save on power bills?

There are no magic bullets to save power with the existing appliance line-up in any home. The only ways to save power in your household are not to use your appliances as much, not to open fridge/freezer doors as often, to turn remote-controlled devices (audio/video especially) off instead of leaving them on "standby" and finally, to buy more efficient appliances.

There are no gadgets that can do it for you. SC

Taking the back off reveals a 6μF capacitor, a bridge rectifier, VDR, LED, a couple of smaller capacitors . . . how's that deja vu going now? This shot is virtually same size.

Stuff taken from the "Gadget Guy" website (www.gadgetguy.com.au):

Power savings of up to 24% using the Enersonic Power Saver (and our responses in bold italic)

It's not magic, its science; and its use can be your contribution to the environment by reducing power wastage. ***If this worked, it would be magic!***

The Enersonic Power Saver relies on the physics principle of power factor correction. The Enersonic Power Saver helps to stabilise and synchronise the Alternating Current (AC), that is, the electrical power that is generated by the power stations, and that you as a consumer draw from your household 240 volt power sockets to run your electrical appliances. ***Power factor correction doesn't save you money***

Different appliances use AC power in different ways. An older wasteful style of incandescent filament light bulb uses power inefficiently. Most of the electrical power consumed by this bulb is lost as heat, with only a little light generated compared with the heat loss. ***What does this have to do with anything?***

Power saving through managing inductive and resistive loads

The Enersonic Power Saver will not save energy if all you used in your premises were filament light bulbs and electric bar radiators or oil heaters. These are referred to technically as resistive loads.

However, your premises also have many electrical and electronic appliances installed, which can to varying degrees, save energy when The Enersonic Power Saver is installed. These additional appliances incorporate motors, transformers, ballasts and other components, which act as inductive loads, and these tend to distort the AC electrical waveform characteristics. ***Inductive loads don't necessarily distort the waveform.***

In simple terms, the Enersonic Power Saver is designed to help correct these problems caused by the mix of inductive and resistive loads, and to help to smooth out and synchronise the electrical waveform to help provide a better power factor correction. ***As we have demonstrated, it does no such thing!***

The Enersonic Power Saver will provide differing levels of power factor correction depending upon the age and combinations of electrical and electronic appliances that you have installed. More than one Enersonic Power Saver would generally be required to be installed in a typical home or office to help achieve best results. ***$0 saving x 2 Power Savers still = $0 saving . . . as does 5, 10, 500!***

In some instances, power savings of up to 24% have been achieved when used with items such as fluorescent light fittings. ***Offices invariably have power factor correction built into fluorescent lights.***

Reasons to buy an Enersonic Power Saver

1. Up to 24% reduction in your electricity bill. In some cases even more. ***No reduction in electricity bill – in fact, your bill will be marginally higher.***

2. Plugs into any socket. No re-wiring needed – just plug the unit into any power socket on your premises and that's all you need to do. ***A completely true statement (!)***

3. Suitable for homes, shops, restaurants and offices. ***All these, with the exception of homes, have power factor correction already – and power factor is ignored in homes!***

4. No maintenance required. ***What do you do if the internal fuse blows?***

5. Rapid return on your investment. ***There is no return on investment!***

6. 1-1 exchange warranty. ***How about money back if it doesn't do what is claimed?***

7. Environmentally friendly. ***In what way?***

8. It acts as a voltage stabiliser and therefore supplies load with proper voltage during momentary power surges. ***This effect is negligible.***

9. When buying an electrical appliance (eg, washing machine) there is a choice between an appliance of a 'high energy rating', which consumes less electricity and costs more, or an appliance of a 'low energy rating', which consumes more electricity but is cheaper to buy. The Power Saver unit operates on a similar principle and converts the whole electrical circuit to a 'high energy rating circuit' therefore saving you money on your electricity bill. ***It does no such thing – it does nothing to save electricity.***

benchmark

May 2008

DICK SMITH ELECTRONICS

www.dse.com.au

$39.88

SAVE $30

DICK SMITH ELECTRONICS

Adjustable Temperature Soldering Station
Lightweight handle with burn-resistant cable, 45W power, 250°C to 450°C temp. range, 240V powered, with 1.6mm tip and cleaning sponge. T1976

$49.88

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DICK SMITH ELECTRONICS

Benchtop Soldering Fume Filter
Reduce soldering fumes with this compact filter. Inc. low-noise mains-powered fan, 2 activated carbon filters, adjustable stand, and plastic hood assembly. T2346

DICK SMITH ELECTRONICS

250g Lead-Free Solder
A lead-free 1.0mm solder alloy containing flux for general electronics work where earlier lead-based solders cannot be used. This solder is 99.3% Tin and 0.7% Copper. Recommended for use with iron-clad or nickel-clad soldering iron tips. 250g roll. N2632

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OUR BEST EVER PRICE!

iroda.

PT-200 Butane Powered Blowtorch
Powerful, heavy-duty butane blowtorch with adjustable flame for hobby users. Electronic ignition, with temperatures up to 1300°C, and up to 60mins use per refill. Internal brass and ceramic parts for precision operation. Colour may vary. T1101

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$24.88

SAVE $12

THIS MONTH ONLY

SAVE 30%

TV Cable RG-59U Economy
Economical 75 ohm dual shield coaxial cable suitable for indoor use on analogue TVs in areas where there is a reasonable signal. Great for making patch leads. W2080

90¢/m EACH

SAVE 39¢/m

THIS MONTH ONLY

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Low cost dual shield 75 ohm analogue TV coaxial cable suitable for indoors and outdoors in areas where there is a reasonable signal strength. W2081

95¢/m EACH

SAVE 34¢/m

THIS MONTH ONLY

75 Ohm TV Coaxial Cable RG-6
Quality shielded low loss heavy duty coaxial cable that is suitable for digital television installations. W2084

$1.29/m EACH

SAVE 30¢/m

THIS MONTH ONLY

Cable Harmony HD Video Audio Cable
Suits high definition video and audio cabling hookups. W2003

$2.08/m EACH

SAVE 90¢/m

24

Promotion from 30/04/08 to 27/05/08

Helping Hands with Magnifier

Heavy cast-iron base for stability, a magnifying glass, plus adjustable position alligator clips to hold an item still while you're working on it. T5715

$6.88 SAVE $5

16pc Slim Bit Set with Ratchet Handle

Uses 45mm long super-hard S2 grade 4mm Hex bits that are thinner than standard bits, allowing access to recessed screws in a wider range of equipment. Includes a reversible direction ratchet driver handle and bit storage holder. T6333

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64-Piece Bit Set and Case

Packed in two soft plastic storage cases for ease of carrying. Includes a magnetic bit holder. Each set contains: security Torx bits, Hex bits, Tri-wing bits, Spanner bits, Slotted bits, Pozidrive bits, Square bits, Phillips bits, Clutch bits, Torx bits, Hex to Square adaptor. T4501

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Soldering Iron Tip Cleaner

Low abrasion spiral-brass for easy tip cleaning, with no water required. Includes metal holder with non-slip rubber base. T2007

$3.99 SAVE $5

Anti-Static Solder Sucker

Easy-to-clean solder sucker with a strong metal body, excellent suction and a heat-resistant Teflon tip. T2567

$4.99 SAVE $7

Heavy Duty Solder Sucker

Solidly built plastic housing, strong spring assembly, dual "O" ring seals for better suction, easy to open for waste solder removal. T2574

$6.99 SAVE $8

Heavy Duty Soldering Iron Stand

Diecast heavy duty construction with rubber feet to prevent scratching your desk, also includes a "spiral brass" style tip cleaner. T1256

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QUALITY FINISH!

Diagonal Nippers

Made from high quality carbon steel, with full cut edges so they're ideal for precise circuit board work. They have smooth grip insulation and are spring loaded. T3337

$4.98 SAVE $5

Nibbling Tool

Allows you to cut almost any shape or size of hole in sheet steel to 0.6mm thick or light alloy to 1.5mm thick. It follows curved or straight lines with ease and is also great for use on many plastics. T4945

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Mini Diamond Tipped Engraver

Compact, battery-operated with a diamond-coated 2mm diameter bit. Can be used on many glass, ceramic or metal surfaces. Supplied with battery case and lead. T4776

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16-Piece Servicing Tool Kit

Wide range of servicing tools in a handy zippered carry case. Includes wire cutters, long-nose pliers, IC inserter, hex drivers, various screwdrivers, insulated tweezers and more. T4843

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350pc Cable Tie Pack

Stock up now! Pack contains 100pcs ea of natural & coloured 100mm x 2.5mm, 50pcs ea natural & coloured 200mm x 2.5mm, and 50pc coloured 280mm x 3.5mm cable ties. H5064

$6.88 SAVE $6

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Solidly built and well-finished plastic toolbox with a removable internal tray, fold-out storage in the lid and 30kg max capacity. H4597

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Lab Power Supply 0-30V DC 5.0A

Regulated DC power supply, 0-30V adjustable output with current up to 5A continuous at all selectable output voltages. Adjustable current limit control (0-5A), high and low current front panel terminals, solidly built case, thermostat controlled internal cooling fan and overload protection. Q1760

$129 SAVE $40

*Conditions apply. See in-store for details.

DICK SMITH ELECTRONICS

$12.88
SAVE $7

DICK SMITH

Illuminated Pocket Magnifier
Great for checking components, PCBs, and other items where a magnified view is required. Features a large 26mm coated glass lens, 10x magnification, carry pouch and a white LED to provide lighting of the viewed item. Requires 3 x "AAA" size batteries. T4597

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DICK SMITH

Stainless Steel Digital Callipers
These stainless steel digital callipers feature a 4-digit LCD screen, internal and external measuring jaw, depth measuring blade, mm & inch measurements, and zero setting. Supplied in a foam-lined carry case with a battery and detailed instructions. Q1382

PERFECT FOR THE HOBBYIST

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DICK SMITH

Magnifying Desk Lamp
Work with small items more easily with the magnified and illuminated view provided by this magnifying desk lamp. Uses 2 x 10W Halogen bulbs, quality glass magnifying lens, flexible gooseneck, and removable AC adaptor. T4599

Lug Crimping Tool
A handy crimping tool when you're working with non-insulated terminals. Has a strong metal frame and jaws, coated handles and a cable cutter. Suit 10-28AWG wire. T3528

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DICK SMITH

4/6/8 Pin Modular Crimp Tool
Cuts and strips cables as well as crimping various 4-pin, 6-pin and 8-pin modular connectors including 4P4C, 6P4C (RJ-11), 6P6C (RJ-12), and 8P (RJ-45) varieties. Rugged metal construction for accurate crimps. T2923

$29.99
SAVE $10

Ratchet Coaxial Crimping Tool
Perfect for F, BNC, TNC, N, Teflon, Thinnet PVC and Fibre-Optic connectors. Has an accurate ratchet drive and double jaws for single-action crimping. Heavy duty metal construction for reliable operation. T3537

$29.88
SAVE $10

Energizer

Penlite Torch
Compact with pocket clip. Concentrated pre-focus light beam. Y2099

$7.88

DORCY LED Headlamp
Ideal for use when your hands are not free, 3 super bright LEDs, adjustable headlight and headband, slide On/Off switch, up to 28hr run time on 3 x AAA alkaline batteries (included). Y1253

$10.99

SIMPLY WIND HANDLE TO USE

NO BATTERIES OR POWER NEEDED

DORCY LED Dynamo Flashlight
Simply wind handle to 'POWER UP' light, renewable energy - alternative to power light, ideal for emergencies at home, camping and cars. No more bulbs or batteries required. Y1277

$15.99

Dorcy Super Bright LED Flashlight
High powered LUXEON 1 watt LED light source, lightweight aluminium casing with rubber hand grip, projects over 30 metre beam. Y1244

$39.88

ARLEC

Rechargeable Spotlight
Powerful 500,000 candle power incl.12V car adaptor, Ideal for camping or other outdoor uses. Y1243

$29.88

ARLEC

Rechargeable Double Vision Searchlight Torch
Powerful 2 million candle power combined spotlight and searchlight with a swivel handle that converts to pistol grip. Ideal for camping, hunting or general outdoor use. Incl. 6V 4 amp SLA battery plus 240V adaptor. Y1249

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PERFECT FOR HOME, GARAGE OR SHED

DSE

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Mini PIR Alarm with Two Remotes

This movement-activated alarm is great for the garage or shed. It sounds an ultra-loud 130dB siren and monitors a 7m range in a 60 degree arc. L7228

EASY TO INSTALL
NO WIRING

$198
SAVE $50

Home Automation – Timed Lighting and Appliance Kit

Automate lighting & appliances within minutes! Activate at the touch of a button, switch on bedside lamp and turn on the kettle at the same time. Simple and easy DIY installation. Easily expandable. L6026

EXCLUSIVE ONLY SOLD HERE!!

$797

Swann

Home/Office Surveillance System

Records onto the massive 160GB hard drive using 4 included cameras either independently or simultaneously. View recorded images on your computer via a USB back-up. Easy connection to your TV. L6111

DICK SMITH

$6.88
SAVE $7

3.5 Digit LCD Panel Meter

13mm LCD display, 200mV full scale input sensitivity and single 9V DC operation, high input impedance >100M ohm, easy bezel fixing method. Reading rate of 2-3 times per second. Q2220

OUR BEST EVER PRICE!

DICK SMITH

$49
SAVE $30

Auto Ranging Digital Multimeter

Auto-ranging 3999 count multimeter with backlighting plus capacitance, frequency and temperature readings. Inc. sleep mode, fuse protection plus diode & continuity tests. Supplied with test leads, test clips & K-type thermocouple. Q1471

DICK SMITH

$59.88
SAVE $20

3.5 Digit LCR Multimeter

Measures inductance, capacitance, frequency, resistance, plus AC/DC current and voltage. Also tests transistors, continuity and diodes. Large 2000 count LCD screen, auto power off, and low battery warning. Complete with test leads & holster. Q1559

DICK SMITH

$69
SAVE $30

Deluxe Dual Input Thermometer

Compact, dual input 4.5 digit digital thermometer, complete with 2 x K-type sensors. Offers both Celsius and Fahrenheit readings. Beeper sounds when preset temperature limit is exceeded. Q1437

OUR BEST EVER PRICE!

DICK SMITH

$88
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10MHz Single Channel Oscilloscope

An economical and sensitive 10MHz Oscilloscope that's easy to operate, making it ideal for a wide range of hobby and educational uses. Supplied with a 1:1 & 10:1 switchable CRO probe, tiltable carry handle and detailed instruction manual. Q1803

DSE

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SAVE $3

Adaptor HDMI Female – Female

A HDMI female joiner to allow the extension of two HDMI cables that also doubles as a "gender changer" from male HDMI to female. P6720

DSE

Right Angle HDMI Male to HDMI Female Adaptor

Right angle HDMI (High Definition Multimedia Interface) Male to HDMI Female Adaptor – great for those tight spots around the back of your high definition screen or TV. P6721

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NEW!

DSE

Adaptor HDMI Male – DVI Female

A HDMI male to DVI female adaptor that changes one digital format connector to another conveniently. P6723

$17.88

DSE

Adaptor HDMI Female – DVI Male

A HDMI female (socket) to DVI male adaptor that works the opposite way to P6723. P6724

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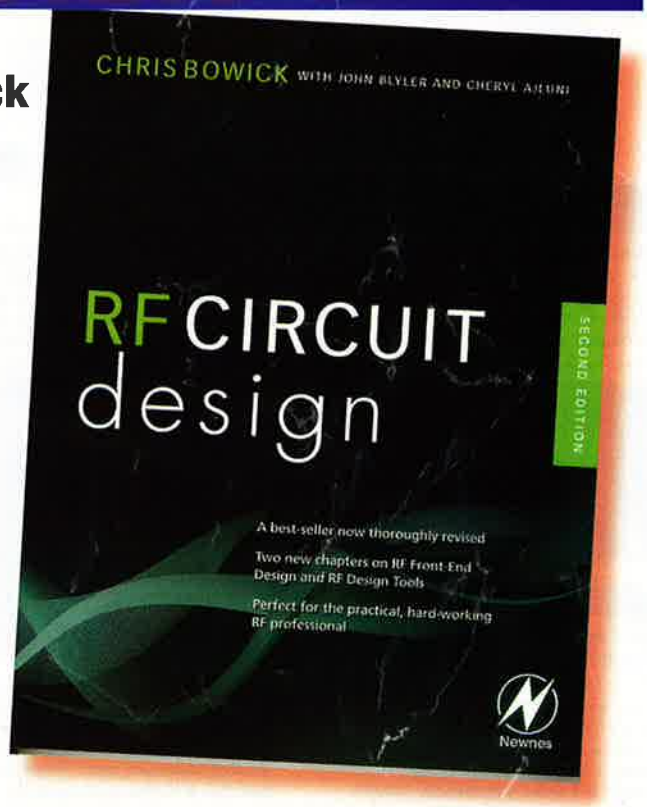
Terms and conditions: Offers start 30/04/08 and end 27/05/08 or while stocks last.
No rainchecks. No layby. Offers may not be available in some reseller or franchise stores.

BOOK REVIEW

By Leo Simpson

RF Circuit Design by Chris Bowick

2nd edition published 2008 by Elsevier Inc.
244 pages, 279 x 217mm, paperback.
ISBN-13: 978 0 7506 8518 4 $67.00


CHRIS BOWICK WITH JOHN BYLER AND CHERYL AJLUNI
RF CIRCUIT design
SECOND EDITION
A best-seller now thoroughly revised
Two new chapters on RF Front-End Design and RF Design Tools
Perfect for the practical, hard-working RF professional
Newnes

This is the long-awaited second edition of a book which has been one of the most popular and highly-regarded text books on the subject of RF technology. At first thought, most people regard RF design as pretty esoteric and not of much interest or relevance to the wider field of electronics. This is a big mistake. For a start, all forms of RF communications are just as important as they have always been.

Apart from conventional radio and TV broadcasting, both of which are now in digital form and ever-expanding, there is a huge range of communications services which were either very new or largely unthought of 25 years ago, when the first edition of this book was produced. Most significant of these would be mobile phones, the many forms of satellite communications, including GPS navigation, satellite TV, EPIRBs and so on. More recently there have been all the so-called "wireless" protocols such as Bluetooth, Wifi, Wimax, Zigbee and others. So RF technology is more important than ever.

In addition, anyone who wants to be proficient in the design of switchmode power supplies and amplifiers and any fast data communication system really needs to have a good basic knowledge of RF technology.

You only need to read the first chapter of this book to see how relevant it is to modern electronic design. This chapter is on components and systems and on the first page it mentions "skin effect". How many misconceptions are there about this effect among hifi enthusiasts? You only have to read a few paragraphs to realise that skin effect is of negligible importance in audio systems, despite what is promoted by the makers of expensive high-falutin' speaker cables.

Then on the second page there is the calculation of the inductance of a straight piece of wire. "Not too important", you might think. On the contrary; when we were recently developing our high power switching speed controller (SILICON CHIP, March & April 2008) a few quick calculations to determine the inductance of the heavy connecting leads from the battery emphasised the importance of this parameter, especially when high currents and high switching speeds are involved.

The same chapter goes on to discuss when resistors are no longer resistive but inductive, when inductors can be capacitive and when capacitors can be inductive, dependent upon frequency. Other topics within the same chapter include winding inductors on toroids, and ferrite versus powdered iron cores.

Chapter 2 discusses resonant circuits (parallel not series) in detail, which is necessary as background for chapter 3 which is on filter design.

I should note that the entire discussion is on passive filters involving inductors and capacitors. Chapter 4 deals with impedance matching – a most important concept for RF design. It also introduces the Smith Chart, a circular chart which is most useful for impedance calculations. The Smith Chart is a mystery to many people who are otherwise well "clued up" but it is fairly easy to use and you do not need to understand the mathematics behind it.

Chapter 5 discusses transistors at radio frequencies while chapter 6 builds on that in discussing RF amplifier design, using Y and S parameters. Both these chapters are on small-signal design but chapter 7 goes on to Power Amplifiers (large signal) including class-B and class-C operation. This is a completely different ball-game to anyone who is familiar with class-B audio amplifiers.

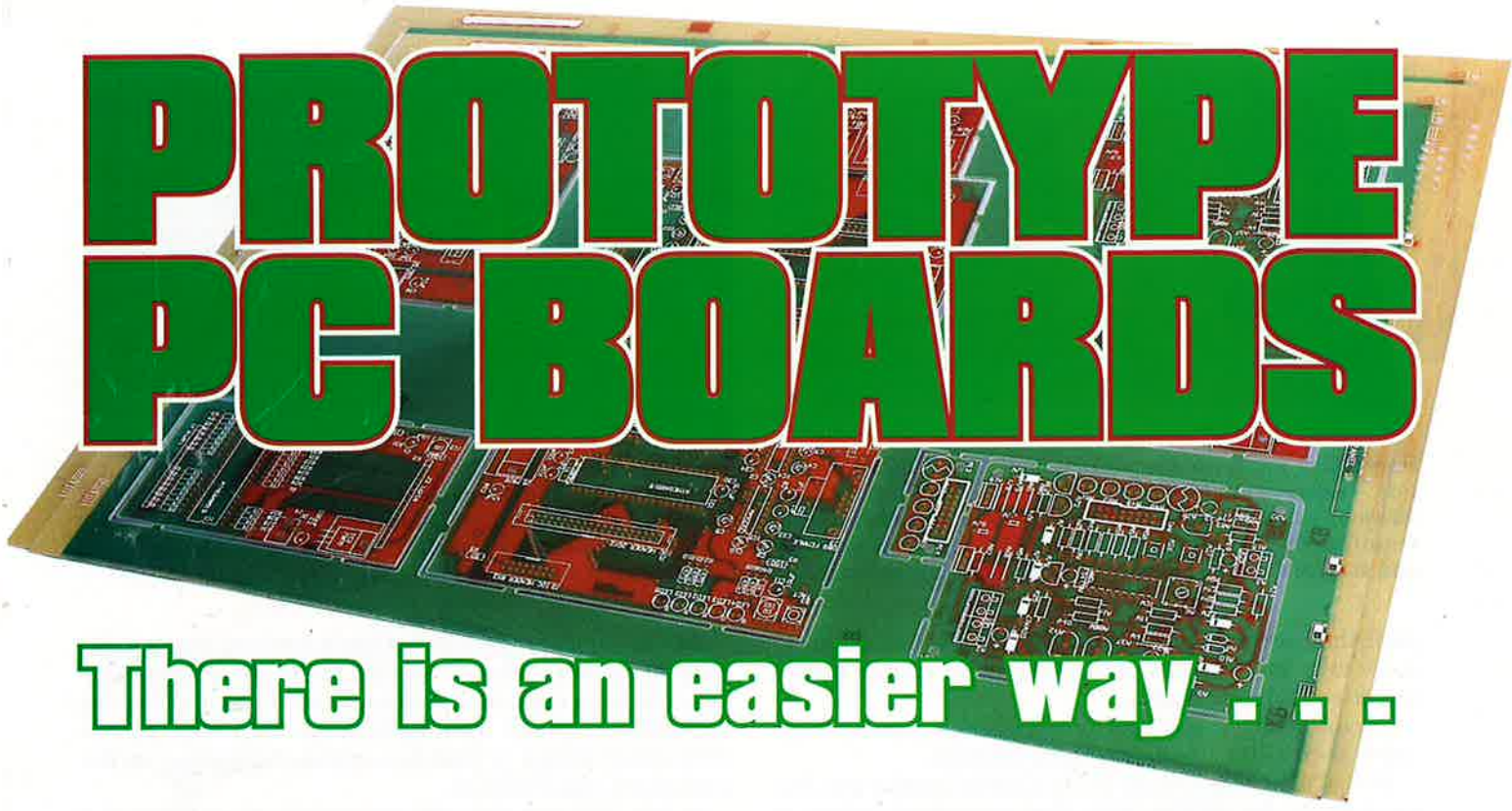
Chapter 8 is devoted to RF front end design for receivers and transceivers and here it covers the gamut from simple AM to the latest 3G design. Finally, chapter 9 is on RF design tools, including those needed for field programmable gate arrays (FPGAs), programmable logic devices, integrated circuits, PC boards and systems on a chip (SOC).

Considering that the book is fairly short at just 244 pages, it packs in a great deal of useful information. It is well written and while there are quite a few formulas and mathematics to work through, it is most worthwhile.

In conclusion, even if you are not involved in RF design, this is a most useful book and should be in the reference collection of every designer.

The book is available from the SILICON CHIP bookshop.

PROTOTYPE PC BOARDS



There is an easier way . . .

If you're a small manufacturer, design lab or college without in-house PC board prototyping facilities, who do you turn to? It's a problem a lot of organisations face – even SILICON CHIP – but there are answers out there . . .

by Ross Tester

Commercial prototyping services are not new – they've been around pretty much since PC boards started being used extensively in, what, the 1960s? By and large, they've concentrated on the one-off board as an adjunct to their main game – commercial PC board manufacture.

A potted PC board history

When PC boards first came out, producing artwork for the pattern was a labour-intensive and exacting process. First of all, the pattern had to be worked out by the designer or engineer, then hand-drawn by a skilled draftsman (yep, very few girls back then) using black ink on either film or paper.

I well remember one such draftsman where I worked who had all-but finished such a drawing – a rather large one at that – and then knocked over his bottle of ink (guess where!). A week's work, literally in the bin . . .

Once the drawing was finished, checked and checked again, a photographic negative had to be produced, usually involving a trip to a photo lithographer. Then the board had to be produced using one of several photo-sensitive processes.

Later came drafting tapes and pads, which allowed the board pattern to be laid out on film and used directly with positive photo resists. However, track widths (or more specifically track gaps) had to be kept quite wide so that the photo resists (and production processes) of the day could handle them.

Another memory from way back then is the late Ron Bell, founder of RCS Radio (and one of Australia's early PC board gurus!) complaining bitterly to the project designers at Electronics Australia when we used "25 thou" tapes and spacing instead of his minimum of "35 thou"!

"No-one in Australia can produce boards with that spacing," he said. Imagine how Ron would be today with 5-thou tracks and spacing over multiple layers!

PC board PC software

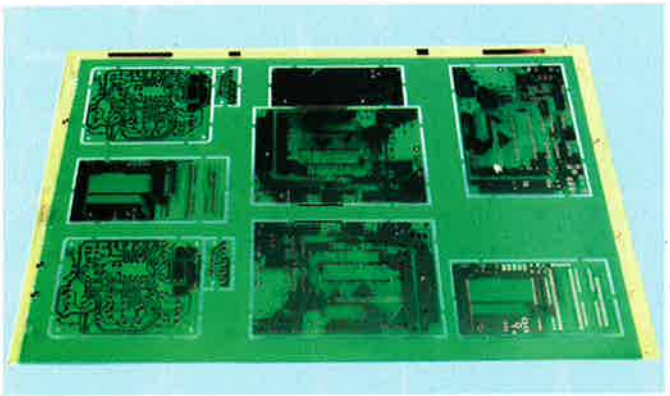
It must have been the late 1980s or early 1990s when software for printed circuit board design started appearing (remember Autotrax?)

Since then, there have been lots of board layout packages brought out – some excellent, some average and some, well . . . Some were so expensive they were way beyond the home constructor but believe it or not, some were actually freeware or shareware.

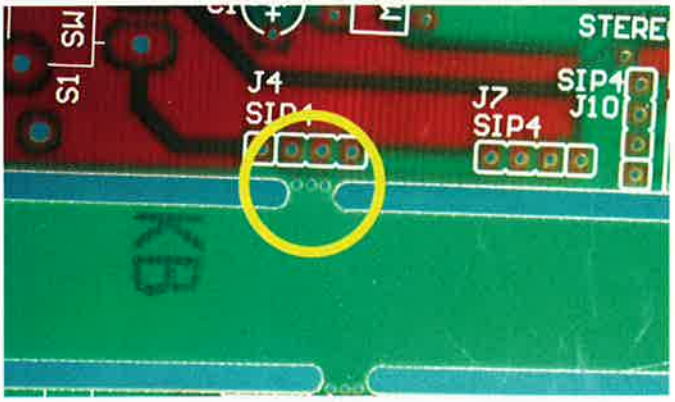
OK, so you've designed your masterpiece on the computer and even had the software check it out to make sure there are no mistakes. Where to from here?

As you might imagine, SILICON CHIP faces this dilemma with just about every project we design, as the vast majority are based on PC boards.

We've been down the path of the D-I-Y prototype PC board – we've even



Here's how you'll receive your "panel" of PC boards from IMP. There are ten boards on this standard-size (417 x 264mm) panel and we could have squashed another in if required. The boards are all drilled, plated, solder masked and screened with a component overlay on the reverse.



Each of the individual PC boards is about 95% cut out but remains secured to the panel as shown above (highlighted by the yellow circle). Even these lands are themselves drilled with a series of small holes to make removal of the board from the panel an easy task . . .

published several articles about it. And we've achieved some very good results, particularly with today's photo-sensitive PC board blanks.

For the hobbyist, we stand by everything we said in those articles – it's still a perfectly viable process.

However, we have to say it can also be a messy process, particularly the etching side. One un-noticed splash of etchant on a shirt and it's off to shirt heaven (or more likely to shirt hell with the expletives undeleted!).

What's more, under- or over-etching is far too easy to do, with shorts between tracks or breaks in tracks too common. Again, they're easy to miss and Murphy says they'll only show up when the smoke escapes at first turn-on.

We've even tried a milling process, where a computer-controlled mill grinds off the unwanted copper and even drills the holes. It works . . . but it takes time. And the mill is not exactly cheap!

Speaking of holes, all bar the milled boards must be drilled. If it's a large, complicated board, that Murphy bloke again says you're bound to miss one or two and only discover them when a chip won't fit in!

So what we needed was a prototyping service that wasn't too expensive and provided reasonably quick turnaround. It needed to handle electronic lodgement of computer files.

We think we've found such a service! In fact, we've used it quite a number of times now and cannot fault the end result – except where they tell us that the end result has a fault (more on that in a moment).

And lest you think that we at SILICON CHIP get a cut rate for mentioning them, we can assure you that we pay the same rates as everyone else! It's just that we have found the service so good, we thought we should tell everyone about it!

Enter the Gladiators . . .

It's called IMP Printed Circuits Pty Ltd, a member of the Codan Group and is based in Cavan, a northern suburb of Adelaide, SA. These days, with high-speed broadband and fast courier services, that's as close as the office next door!

With more than 40 years experience in the PC game (the company was established in 1964), they're now recognised as one of the leaders in the industry.

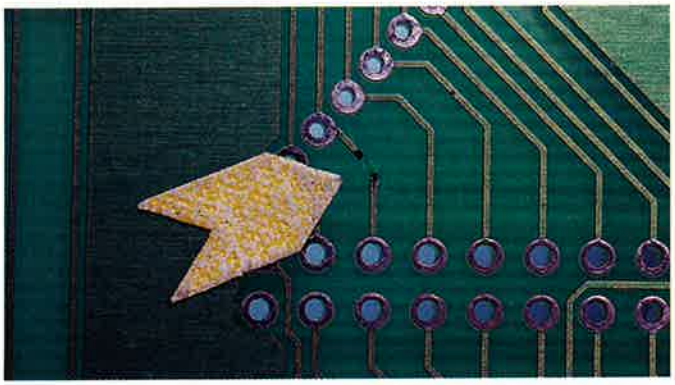
IMP PC offer a range of prototyping services, from a lightning-fast 24 hour priority through to the one we generally use, a 5-day sample and prototype panel service. They're an RoHS-compliant manufacturer and can offer boards with either leaded or lead-free solder, depending on the customer's requirements.

In fact, they can also offer immersion silver finish and even immersion gold finish.

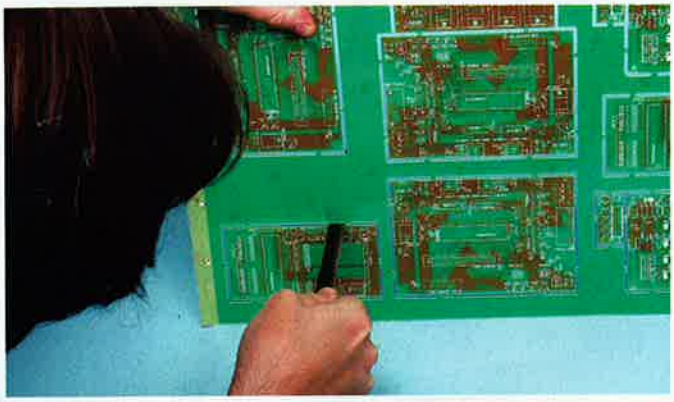
That word "panel" requires a little explanation. It's not a front or rear panel as we're used to – rather, it's a panel of PC boards, as many as will fit on their standard sheets: 417 x 264mm useable area. They also have a large sheet with 493 x 290mm useable area.

This gives you a clue to the way they work. Rather than produce just one PC board at a time, they offer the customer the opportunity to have a number made at the one time. They could be duplicates of the one PC board or they could be completely different boards. We generally get two boards of each board made – just in case – and then fill the panel with other project prototype boards or even get some boards made that we need.

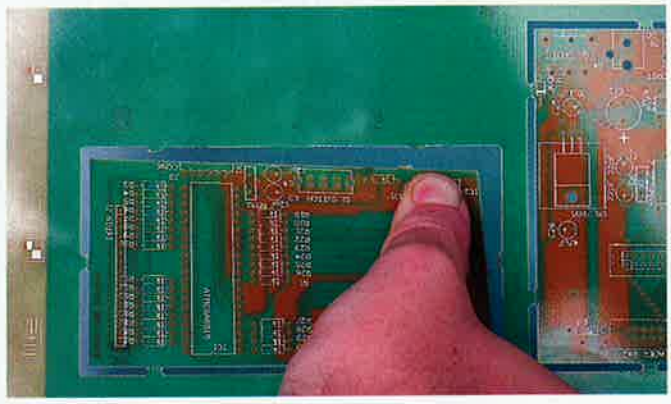
The boards that come back to us come still attached to the panel – but cutting them out is very easy (most of the board edge is cut – or more accurately, it's milled – but just a few "bridges" of blank [etched] fibreglass hold the board on the panel. See the photo series above.



This board has a flaw (in this case a broken track) – so when IMP send it to the client, it has a highlight – a huge arrow marking the spot. As it is a prototype, such imperfections are easily cured!



. . . and this is how it's done. The long hair and hand belong to SILICON CHIP's Mauro Grassi, who is shown here removing one of the individual PC boards by cutting through the land with a hacksaw blade. As we said before, this already has a series of holes drilled to mke it easy.



You don't even have to cut through all four sides to remove the board. We normally find cutting through two sides is enough; a bit of thumb-power is all that's needed to break it free. The slightly rough edges are very easy to clean up with a file.

The boards are not simply etched – they are drilled, plated, solder-masked and a component overlay is silk-screened on the reverse side. In other words, they're complete ready to use once removed from the panel.

How many boards?

How long is a piece of string? It all depends on the size of the individual boards. They're fitted onto the panel for minimum wastage allowing, of course, for a small space between each board. The accompanying photo of a recent panel we had made give you a good idea.

How many layers?

IMP PC's sample and prototype service can produce any board from single sided and double sided right through to eight layers. Naturally, as the number of layers goes up, so do the prices.

Yield

We hinted before that PC board production is not an exact science. It's pretty good, but with the thin tracks used on today's boards, there will be times when the boards aren't absolutely 100% perfect.

We've only struck this once or twice but it so happened that one of the boards we recently received had a flaw in it.

It's not like the days of yore when you had to go over your own produced board with a magnifying glass – IMP PC do it for you. If they find anything wrong, they highlight it with a big yellow arrow.

You might wonder why they don't redo the panel if it has errors: surely you want your PC boards perfect. Remember, we are talking prototype boards and it is highly likely that there will need to be mods anyway, so a repaired track is not a significant problem. However, they will redo the panel if it doesn't achieve their pre-agreed yield standard.

Lodging board patterns

Like most PC board houses, IMP PC work from Protel PC board files which are electronically submitted.

They do have their own specific requirements for lodgement so it's worth a look at their website (or call them) before you send in your first batch. In fact, you'll need to do this to establish an account or arrange credit card payment for your first order

How much?

The standard prototyping service, with 5-day turnaround, costs $285 for the standard sheet and $335 for the large sheet (for a single-sided board).

OK, at first glance this sounds expensive but look at what you get: while they're called "prototype" boards, they're every bit as good as the production boards IMP PC will also be glad to talk to you about! (IMP PC also work with several quality overseas suppliers who can produce volume boards at the right price).

Even if that was for just one board, that's chicken feed for most companies – they would have spent many, many thousands of dollars developing the project and probably paid several thousand dollars for their PC board software to boot (you like that pun?). What's more, have a look at the photo of the panel of boards above that we had made recently. Count 'em – there are ten reasonable-size boards on that panel with space for at least one more.

$335 divided by 11 is just over $30 per board. So cost really isn't an issue. Time (5 working days) shouldn't be an issue with the right planning – and if a board really is required urgently IMP PC offer a 24-hour service. Yes, you'll have to pay extra for that – but if it really is that urgent . . .

With the "rush" service, if the PC board file is received prior to 10AM, the finished panel will be despatched from the factory by midday next day.

Incidentally, if you want extra panels produced at the same time as your first, they will cost $75 for the standard panel and $95 for the large.

And if you need more advanced boards, IMP PC can handle just about any requirements. They have a freecall number in both Australia (1800 888 543) and New Zealand (0800 441 500) for technical enquiries. SC

For more information, contact
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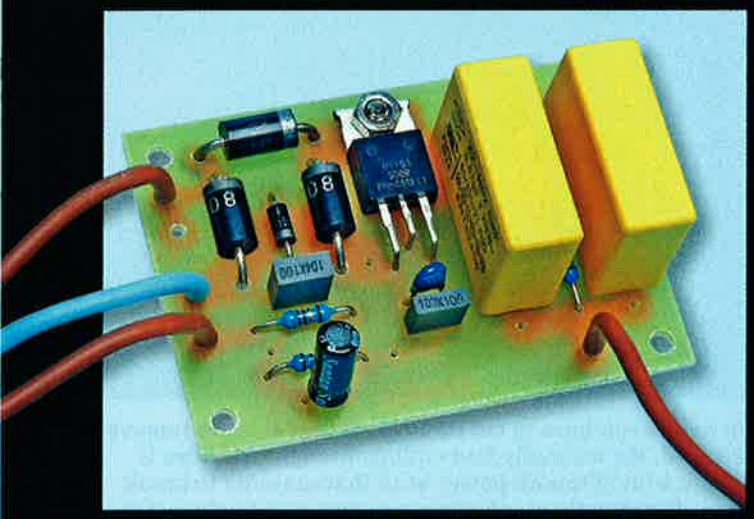
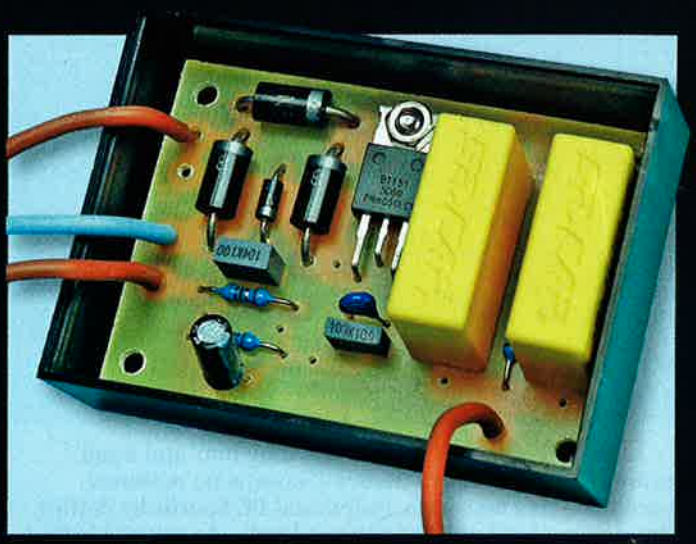
Website: imppc.com.au





Replacement CDI Module for small petrol motors

By JOHN CLARKE

If the CDI module in your motorbike, outboard, ride-on mower or other small petrol motor fails, you could be in for a shock. Depending on the brand or model, they can cost up to $400. You can build this one for less than $50 and it will do the same job for most engines.

READERS HAVE BEEN asking us for years to design a drop-in CDI module for motorbikes, outboards and other small petrol motors. You can understand why. It can be a real shock to front up to your local dealer and find out the price for such a module. It is even harder to justify the prices charged when you see the circuit components involved.

Those days, a great many small petrol engines use a Capacitor Discharge Ignition (CDI) module. The high-voltage capacitor is charged directly from a generator located on the flywheel. A battery may still be included and used to drive lights and ancillaries but this is used independently of the ignition.

CDI is a great improvement on the old magneto ignition systems. Not only does the CDI deliver higher spark energy but it also dispenses with the points which were inevitably subject to wear and required periodic cleaning, adjustment and replacement.

The one drawback is that CDI systems don't last forever – they can fail. While the failure can be within the flywheel generating coils or the ignition coil, it is most likely to be the CDI module itself and then you will find that the replacement can be very expensive.

The CDI Module described here may be used to replace a failed factory unit for an engine that incorporates a generator and trigger coil to provide the high-voltage and the firing point. Most of these CDI systems operate in a similar way but there are variations in design that use the opposite polarity for voltage generation and are therefore unsuitable for our module.

While some tests can be performed to check for suitability, we cannot guarantee that the module will work for every engine. Even so, because this

CDI Module uses cheap and readily available parts, it may be worth a try if you are unwilling to fork out lots of hard cash for a genuine replacement module.

How CDI works

Fig.1 shows the connections required for a typical CDI module. The generator (magneto) coil provides the high voltage to charge a capacitor (in the CDI module), while the trigger coil provides the signal to dump the capacitor's high voltage charge into the ignition coil. A kill switch shunts the high-voltage supply from the generator to prevent ignition.

Fig.2 shows how CDI works. It comprises three main components: the ignition coil, a capacitor (C1) and a Silicon Controlled Rectifier (SCR). The SCR behaves as a switch. It is normally a high impedance until a small trigger voltage is applied between its gate and cathode. It then conducts and behaves like a diode. After triggering, the SCR switches off when the current through it falls close to zero.

Initially, the SCR is off and capacitor C1 is discharged. Positive voltage from the generator then charges C1 via diode D1 and the primary winding of the ignition coil. The current path is shown in red as "I_C".

C1 is discharged when the SCR is subsequently triggered, allowing current to flow back through the ignition coil primary. This current path is shown in green as "I_D". The fast discharge of C1 and resulting current through the ignition coil causes a high voltage to be developed across the secondary winding of the ignition coil, to fire the spark plug(s).

Once the spark plug is extinguished, the collapsing field of the ignition coil develops a reverse current flow via diode D2 to partially recharge capacitor C1.

Typically, the generator coil delivers about 1A in charging the capacitor up to about 350V. If C1 is 1µF, then it will charge in about 350µs – much quicker than the time between sparks, even in a high-revving engine.

No RPM advance

Note that the CDI Module does not incorporate RPM advance and so it provides a fixed timing from the trigger coil – most common with small engines.

Some engines do incorporate RPM advance using a special trigger coil and magnetic core design that advances the firing edge with increasing RPM. This is achieved by having a stepped or shaped coil core that has a larger gap at its leading edge compared to the trailing edge – see Fig.3.

At low speeds the coil voltage required for triggering is developed at the trailing edge of the magnet but as revs increase, the leading edge of the magnet is able to induce more voltage in the coil and so firing occurs earlier. This is shown in Fig.4.

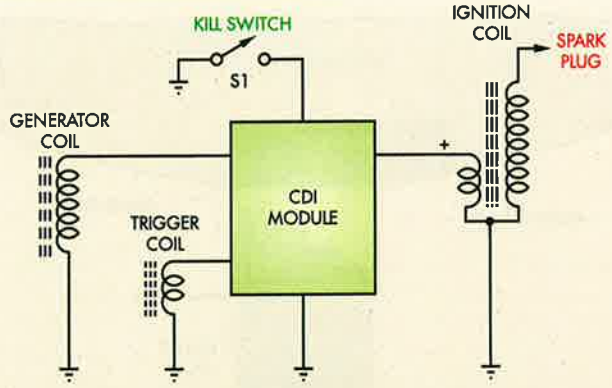
Other designs use electronic advance but these require extra power for the circuitry and tend to be used only with battery-powered systems.

Circuit details

The simplest circuit arrangement for the CDI module is shown in Fig.5. Voltage from the generator coil charges capacitor C1 (and C2) via diode D1 and the ignition coil primary. As previously mentioned, D2 is there to conduct the reverse current flow from the ignition coil after the capacitor has discharged.

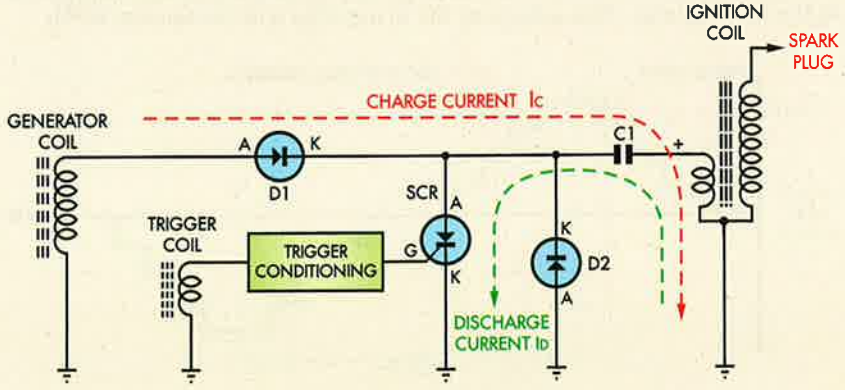
The two in-series 1MΩ resistors across capacitor C1 are there to discharge the capacitor if the SCR does not fire. This is a safety feature that prevents a nasty electric shock if you happen to connect yourself across the capacitor. It takes about two seconds for the capacitor to discharge to a safe value.

Provision has been made on the PC board for two discharge capacitors, C1 & C2. This allows the use of either two 0.47µF capacitors or two 1µF capacitors. A higher capacitance will produce greater spark energy,



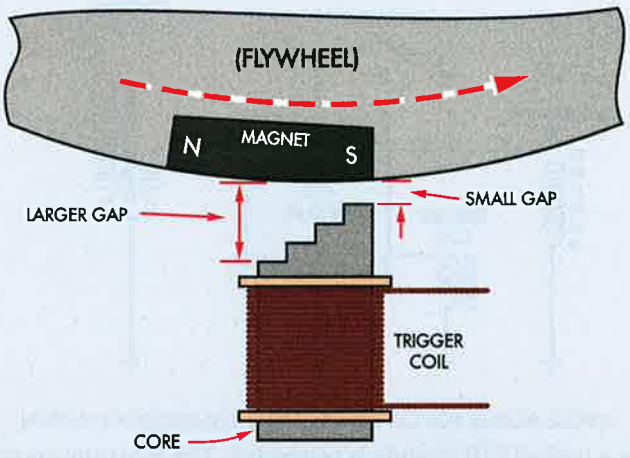
TYPICAL MODULE FOR CDI WITH EXTERNAL CONNECTIONS SHOWN

Fig.1: how a typical CDI module is connected. The generator (magneto) coil provides a high voltage to charge a capacitor in the CDI module, while the trigger coil provides the timing signal to dump the capacitor's high voltage charge into the ignition coil.



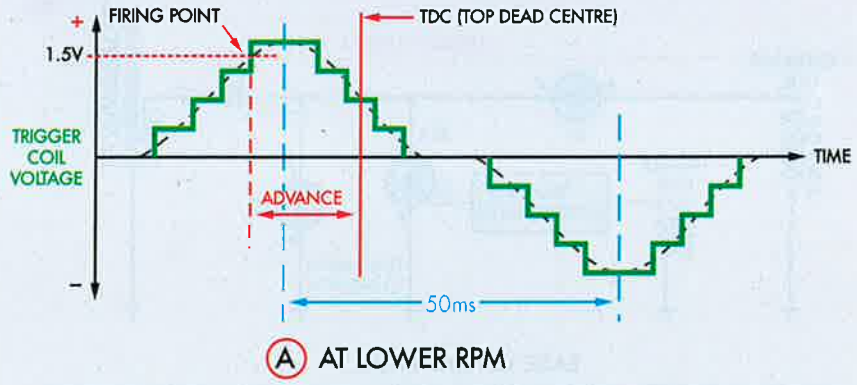
BASIC CDI OPERATION

Fig.2: how the CDI module works. Initially, the generator coil charges C1 to a high voltage (via diode D1). A trigger pulse (from the trigger coil) then turns on the SCR and this quickly discharges C1 by allowing current to flow back through the coil primary.



ADVANCE TRIGGER HEAD DESIGN

Fig.3: some engines achieve RPM advance using a special trigger coil with a stepped magnetic core that has a larger gap at its leading edge compared to the trailing edge. This advances the firing edge with increasing RPM.



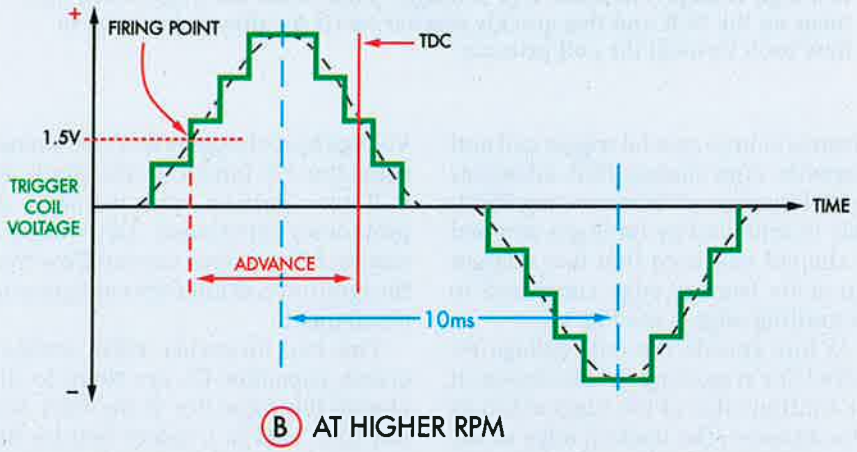


Fig.4: the effect of a stepped trigger core design is shown in these timing advance waveforms. At low speeds, the coil voltage required for triggering is developed only at the trailing edge of the magnet (waveform A). However, at higher revs, the leading edge of the magnet induce a greater voltage into the coil and so firing occurs earlier (waveform B).

provided the generator coil can charge the capacitors to the full voltage in the required time.

The trigger coil provides the necessary signal to trigger the SCR. When the coil voltage goes positive, it feeds current to the gate of the SCR via a 51Ω resistor and diode D3. D3 prevents reverse voltage on the gate while the 51Ω resistor limits the gate current to a safe value. A 1kΩ resistor ties the gate to ground to prevent false triggering, while the 100nF capacitor filters noise and transients that may cause the SCR to trigger at the wrong time.

A kill switch connection has also been provided to shunt the generator current to ground and stop the motor.

Circuit refinements

The simple circuit of Fig.5 works well but additional circuitry can improve reliability and provide for more consistent triggering. The extended circuit is shown in Fig.6.

First, diode D4 has been added across the generator and thus shunts negative excursions across the coil to less than -0.7V. Without D4, the anode of diode D1 can be subject to -350V from the negative swings of the generator. This means that diode D1 could have over 700V across it if the capacitor is charged to +350V.

While D1 is rated at 1000V, D4 reduces the maximum likely voltage across it to around 350V or so and thereby reduces the possibility of reverse breakdown of the diode.

Triggering in this version of the circuit has also been improved in two ways. First, we have added a series 10µF capacitor to the gate of the SCR. This capacitor prevents false triggering due to any DC offset from the trigger coil that may be more positive than it should be because of remnant magnetism in the coil's core. The 1kΩ resistor across the capacitor is there to discharge the capacitor and is high enough in value to prevent it triggering the SCR on its own. Diode D5 prevents the 10µF capacitor from being charged with reverse polarity when the trigger coil output swings negative.

A second improvement involves the use of a negative temperature coefficient (NTC) thermistor across the gate of the SCR. This thermistor reduces its resistance with increasing temperature and is used to compensate for the lowered triggering requirement of the SCR (for both voltage and current) at higher temperatures.

Effectively, the NTC thermistor forms a voltage divider with the 51Ω resistor. At 25°C, the thermistor is 500Ω and so it attenuates the signal from the trigger coil to 91%. However, at 100°C, the NTC thermistor resist-

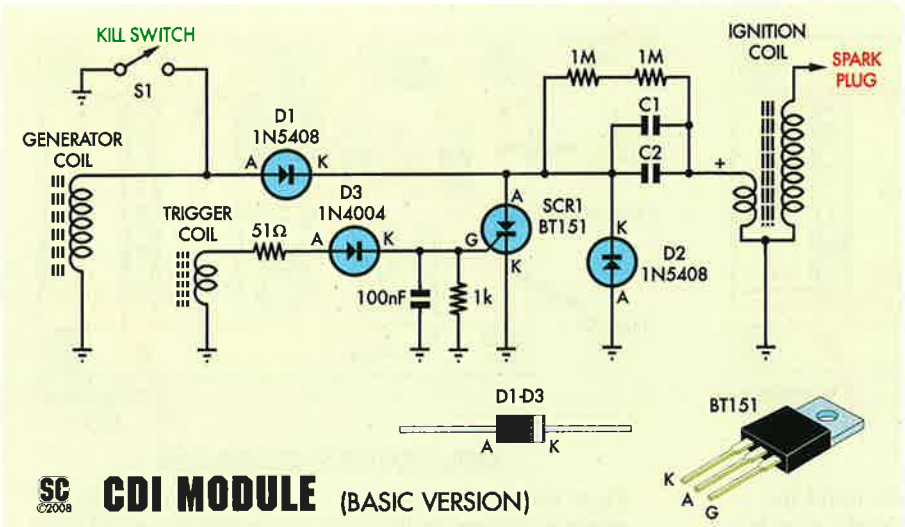


Fig.5: this is the circuit for the Basic Version. The kill switch is there to stop the motor by shunting the generator coil's output to ground, while the 1kΩ resistor on SCR1's gate prevents false triggering due to noise.

ance is around 35Ω and the trigger signal is divided down to 41% of the trigger coil value.

This attenuation in signal level attempts to match the SCR's reduced trigger level requirement at higher temperature. So as temperature rises, the signal is increasingly attenuated and as a consequence, the SCR fires at the same trigger coil voltage over a wide temperature range. Without the thermistor, the SCR would be subject to timing changes with temperature.

Construction

A small PC board coded 05105081 and measuring 64 x 45mm caters for both versions of the circuit. This can fit into a plastic box that measures 70 x 50 x 20mm and this box allows the whole module to be subsequently potted.

Begin by checking the PC board for the correct hole sizes. The four corner mounting holes should be drilled to 3mm, as should the hole for the SCR mounting tab. That done, check the PC board for breaks in the copper tracks or for shorts between tracks. Make any repairs before assembly.

Fig.7 shows the simple version of the circuit, while Fig.8 shows the more complex version. The choice is yours but we recommend the version

Parts List

1 PC board, code 05105081, 64 x 45mm
1 potting box, 70 x 50 x 20mm (Jaycar HB-5204 or equivalent)
1 500Ω NTC thermistor (Jaycar RN-3434)
1 M3 x 10mm screw
1 M3 nut

Semiconductors
1 C122E, BT151 500V SCR (SCR1)
3 1N5408 3A 1000V diodes (D1,D2,D4)
1 1N4004 1A 400V diode (D3 for Basic Version; D5 for Extra Features Version)

Capacitors
1 10µF 25V PC electrolytic
1 1µF 275VAC or 280VAC metallised polypropylene; *or*
2 0.47µF 275VAC or 280VAC metallised polypropylene; *or*
2 1µF 275VAC or 280VAC metallised polypropylene – see text
1 100nF MKT polyester
1 10nF MKT polyester

Resistors (0.25W 1%)
2 1MΩ 1 51Ω
1 1kΩ

Miscellaneous
Automotive wire, crimp connectors, neutral-cure silicone sealant.

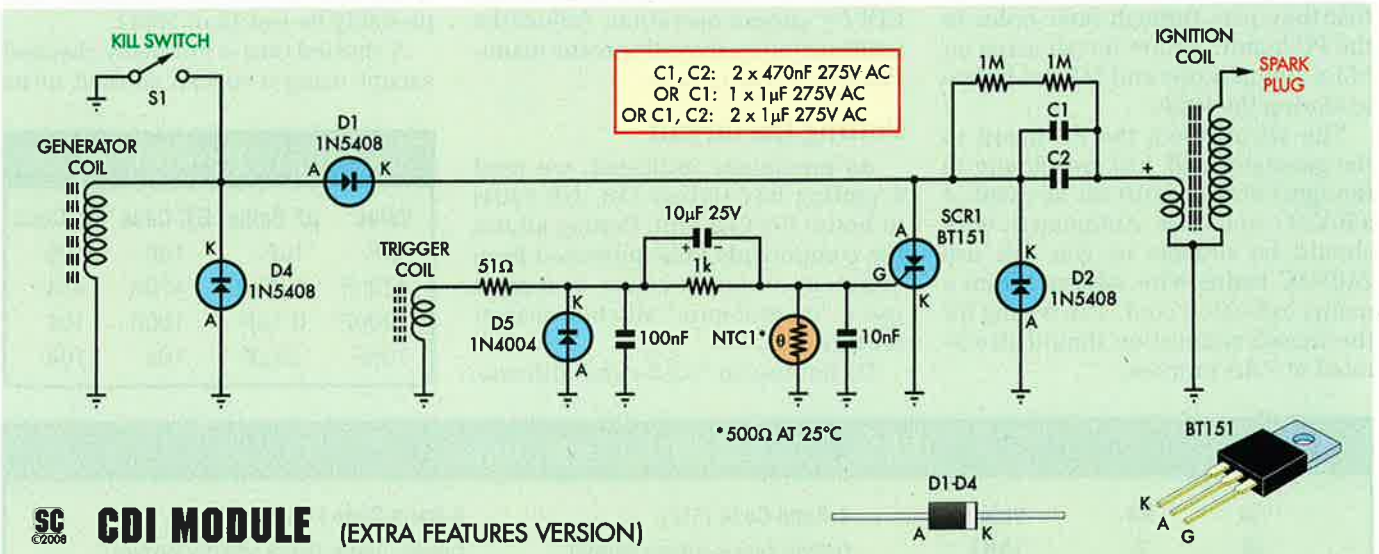
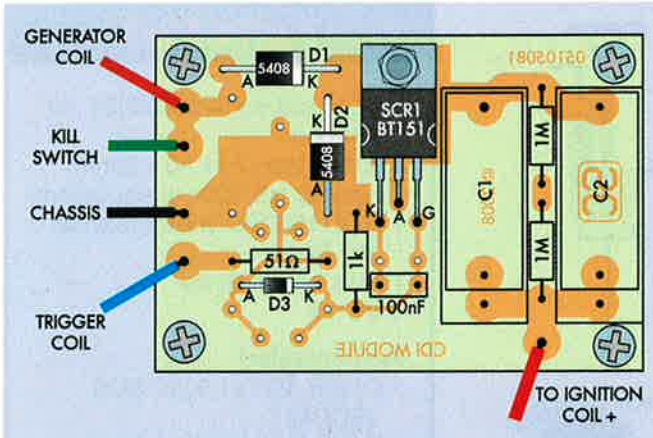
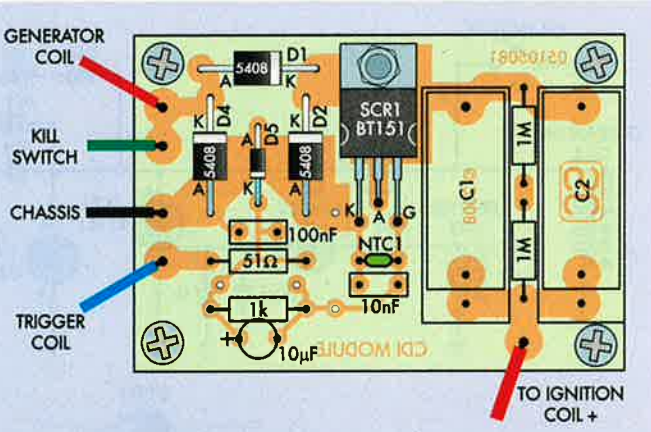


Fig.6: the Extra Features Version includes diode D4 to shunt negative excursions across the generator coil to less than -0.7V and thus limit the voltage across D1 to around 350V. It also features an improved trigger circuit, to ensure consistent firing of the SCR with variations in temperature.



'BASIC' CDI VERSION

Fig.7: follow this parts layout diagram to build the "Basic Version" of the CDI Module. It can be used for non-critical applications.



'EXTRA FEATURES' CDI VERSION

Fig.8: the "Extra Features" version is the one that we recommend you build. Take care with the orientation of the diodes and the 10µF electrolytic capacitor.

in Fig.8. In fact, the following assembly procedure assumes that you are building the "Extra Features" version.

Start by installing the diodes, taking care to orient each one correctly. The resistors can then go in – their values can be checked against the accompanying table and with a digital multimeter.

Next, install the thermistor, the smaller capacitors and the 10µF electrolytic, making sure it is oriented correctly. The discharge capacitor(s) can then be installed. As noted above, we have provided for two capacitors and also for two different lead spacing on the PC board.

The SCR is mounted horizontally with its leads bent down by 90° so that they pass through their holes in the PC board. Secure its tab using an M3 x 10mm screw and M3 nut before soldering the leads.

The wiring from the PC board to the generator coil, kill switch and to the ignition coil must all be rated at 250VAC and 7.5A. Automotive wire should be suitable or you can use 240VAC mains wire salvaged from a mains extension cord. The wiring for the chassis connection should also be rated at 7.5A or more.

By contrast, the trigger lead does not have to be heavy duty but should have suitable insulation for automotive use. Sheath the wires in some flexible tubing to prevent possible chaffing of the wiring insulation. Better still, you may be able to use the existing wiring for the original CDI module.

If you want the best spark possible, you can try adding a second 1µF capacitor in parallel with the first. This may improve the "fatness" (intensity) of the spark. In some cases though, a 1µF capacitance will give the best spark because 2µF may load the generator coil too much and lower the charge voltage.

Once the board is complete, run the external connections and test the CDI for correct operation. Adjust the ignition timing according to the manufacturer's instructions.

Potting the circuit

As previously indicated, we used a potting box (Jaycar Cat. HB-5204) to house the CDI unit. Potting allows the components to be protected from vibration, water and dust. You must use a "neutral-cure" silicone sealant for this job.

Do not use an "acid-cure" silicone, as this will corrode the wires and copper pattern on the PC board.

Note that the capacitor(s) will protrude a little from the top of the potting box. The box can be mounted on the engine frame using suitable brackets. It should be placed away from the exhaust side of the engine.

Make sure that any mounting screws for the box do not penetrate and make contact with the circuit.

Testing the generator coil

Sometimes the generator coil can fail due to either a shorted turn or a broken wire. You can test for a break in the coil by measuring its resistance – ie, between its output and ground. If the coil is OK, its resistance will probably be less than 200Ω.

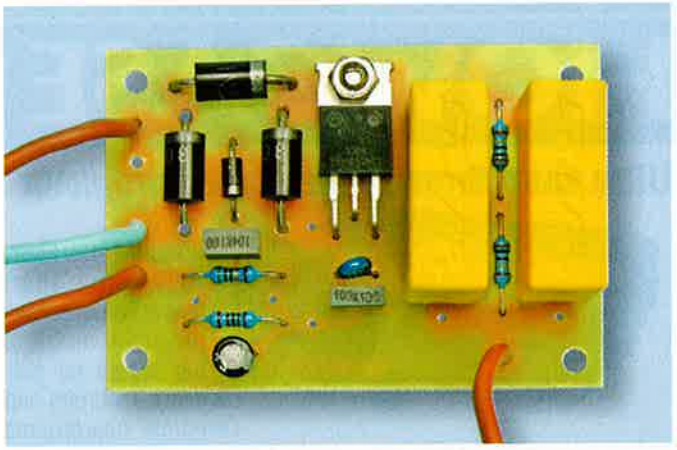
A shorted turn is not easily checked except using a special shorted turns

Table 2: Capacitor Codes

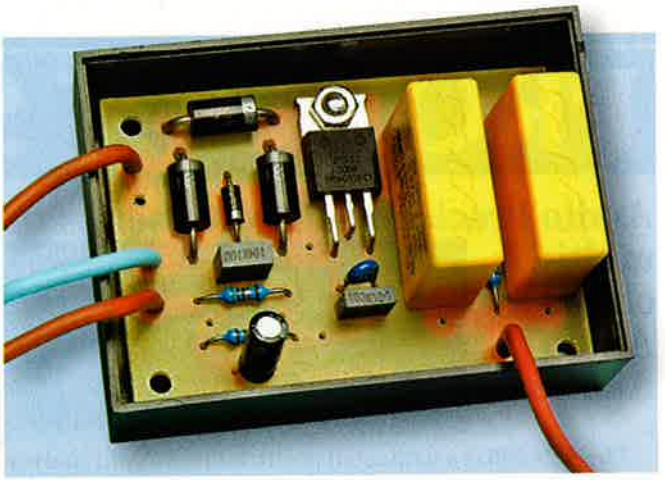
Value	µF Value	IEC Code	EIA Code
1µF	1µF	1u0	105
470nF	0.47µF	470n	474
100nF	0.1µF	100n	104
10nF	.01µF	10n	103

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	1MΩ	brown black green brown	brown black black yellow brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	1	51Ω	green brown black brown	green brown black gold brown



This completed CDI module is the "Extra Features" version. You may have to experiment with the number of discharge capacitors to get the best spark – see text.



The board should be installed in a plastic case and potted using neutral-cure silicone sealant to ensure reliability (ie, to protect against vibration, moisture and dust).

tester. However, you can get some idea if the coil is delivering sufficient voltage by measuring it with a multimeter set to read AC volts up to 300V. The voltage is measured when the engine is turned over.

Take care if making this measurement, since the generated voltage can give you an electric shock. DO NOT touch any of the wiring when turning the motor over.

Note that the voltage measured across the generator coil will not be anywhere near the voltage that it develops when running. That's because the multimeter does not respond well to the low-frequency voltage fluctuations that occur when kicking the engine over. In addition, most multimeters do not respond to the peak of the waveform but to the average of a sinewave.

In practice, you should get a reading of about 50V AC from the coil.

Another way of testing the coil voltage is to connect the CDI module and measure the DC voltage between the cathode of D1 and the chassis while kicking the motor over. The reading should at least get to 200V DC if you can kick the motor over fast enough.

Alternatively, if an oscilloscope is available, the voltage waveform can be measured with the probe set to 10:1.

One point we have not mentioned is the polarity of the voltage. The capacitor needs to charge to a positive voltage before the trigger signal occurs. **If the voltage from the generator coil is negative before triggering occurs, it will mean that the CDI module described here is not suitable for replacing the module in your engine.**

You can check the polarity using a multimeter set to DC volts – it's just a matter of checking that the voltage on SCR1's anode goes positive before the SCR is triggered and negative after the trigger.

Trigger coil testing

The trigger coil can be tested in the same way as the generator coil (ie, measure the voltage between D3 or D5's cathode and chassis as the motor is kicked over). This voltage will be quite small compared to that from the generator coil and only occurs over a short portion of each engine revolution.

Typically, you might measure a trigger voltage of less than 1V using a multimeter set to read AC volts. The trigger coil voltage can also be observed on an oscilloscope.

Of course, the real test is when it is used with the CDI module itself, as it must be able to trigger the SCR. SC

Warning

This CDI module is not intended for use as a replacement for CDI units that generate their own high voltage from an inverter requiring a 12V battery supply.

To replace one of these units, you could adapt one of our previous designs, such as the High Energy Ignition (SILICON CHIP December 1995 and January 2006) or the Multi-Spark CDI (September 1997). Alternatively, you could consider using the Programmable Ignition System from March, April & May 2007.

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PRODUCT SHOWCASE

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Epson's new EMP-400W ultra short throw, wide screen projector makes a big impact for presenters, lecturers and corporate boardrooms delivering a 60-inch wide screen image from only 65cm away.

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With Epson's newly developed high precision lens, the EMP-400W is the only short throw, wide-screen (16:10) projector available. It projects in Wide XGA (1280 x 768 pixels), an increasingly common format for laptops and PCs and it can also be adjusted for interactive white boards (and regular screens) to give aspect ratios of 4:3, 16:9 and 16:10. The 4000-hour, 1800-Ansi-lumen long-life lamp in the EMP-400W, made by Epson themselves, can be replaced easily by loosening a single screw on the hatch on top of the projector.

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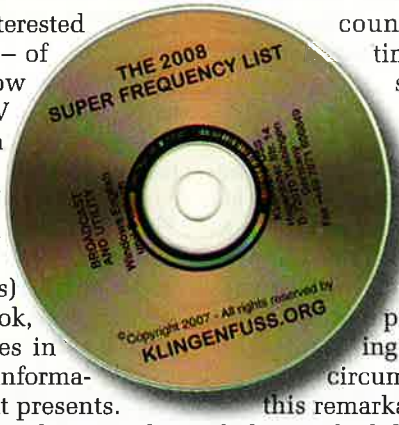
2008 Super Frequency List on CD



Anyone remotely interested in listening to radio – of any type – would know of the World Radio TV Handbook. It has been long regarded as the authoritative listing of radio stations around the world.

Trouble was (and is) is that it *is* a printed book, with all the difficulties in finding and analysing information that such a format presents.

Av-Comm's Garry Cratt has now the perfect alternative: a CD containing the latest clandestine, domestic and international shortwave broadcasting schedules and the most up-to-date HF utility communications freqency list.

Running on Windows of any persuasion, the 2008 Super Frequency List on CD gives you various powerful search tools to find exactly what you want – in less than one second!

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Jaycar's new 200W PA Speaker/ Amplifier Combo

If you're looking for a high-power, self-contained public address speaker/amplifier, this new model from Jaycar should fill the bill nicely.

Sold under Jaycar's "Digitech Audio" brand, with a 200W RMS inbuilt power amplifier and 2-way speaker featuring a 12-inch long throw driver and efficient compression driver, it can really pump it out – whether that be for DJ, school/club/church/conference use, sporting venues or, in fact, practically any PA application.

It has a durable moulded ABS enclosure and a very tough metal grille in front, so it is obviously designed to take the knocks and abuse that all PA equipment suffers!

The amplifier also has a quite versatile mixer feeding it, offering thre inputs – two XLR balanced and 6.5mm unbalanced microphone inputs and one line-level input (RCA and XLR) which can be used for a wireless microphone, CD/cassette player, etc. It also has a line-level output (6.5mm and XLR) for cascading or recording. All inputs have their own level controls and there's a master level control plus bass and treble cut/boost controls.

As you would expect from an amplifier of this power, it's mains powered (via standard IEC mains lead) – battery operation is not an option!

The unit is neither small nor light – it measures 600 (h) x 410 (w) x 325 (d) and weighs in at 16.5kg.

It comes with four screw-on feet – and a nice feature is these feet match recesses in the top of the case so that units can be safely stacked, if desired. Provision is also made for post-top mounting with a standard (internal) top-hat.

Retail price is $399.00 including GST (Cat CS-2517).

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PO Box 107, Rydalmere NSW 2116
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Website: www.jaycar.com.au

Jaycar have moved!

And speaking of Jaycar Electronics, for the third time in a decade or so, they have outgrown their premises, forcing a move to a significantly larger warehouse complex.

Head Office and distribution centre are now located in Rydalmere, about 5km from their old Silverwater headquarters. You'll find them at 320 Victoria Rd, Rydalmere NSW 2116.

Phone numbers have also changed: the main switchboard is now (02) 8832 3200; fax (02) 8832 3232. Jaycar's website remains the same: www.jaycar.com.au

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EMONA

By JIM ROWE

High-accuracy Digital LC Meter

Here's a handy piece of test gear you can build for yourself – a Digital LC Meter for measuring inductance and capacitance over a wide range. It's based on an ingenious measurement technique, delivers surprising accuracy and is easy to build.

MANY MODERN DMM's (digital multimeters) have capacitance measuring ranges, especially the upmarket models. So it's not hard to measure the value of capacitors, as long as their value is more than about 50pF or so.

Below that level, DMMs are not very useful for capacitance measurements. Dedicated digital capacitance meters are available, of course, and they generally measure down to a few pF or so. But if you want to measure things like stray capacitance, they too are of limited use.

It's even worse when it comes to measuring inductors. Very few DMMs have the ability to measure inductance, so in many cases you have to use either an old-type inductance bridge or a 'Q' meter. Both of these are basically analog instruments and don't offer either high resolution or particularly high accuracy.

It's different for professionals who for the last 20 years or so have been able to use digital LCR meters. These allow you to measure almost any passive component quickly and automatically, often measuring not just their primary parameter (like inductance or capacitance) but one or more secondary parameters as well. However, many of these you-beaut instruments also carried a hefty price tag, keeping them well out of reach for many of us.

Fortunately, thanks to microcontroller technology, that situation has changed somewhat in the last few years with much more affordable digital instruments now becoming available. These include both commercial and DIY instruments, along with the unit described here.

Main features

As shown in the photos, our new Digital LC Meter is very compact. It's easy to build, has an LCD readout and fits snugly inside a UB3 utility box. It won't break the bank either – we estimate that you should be able to build it for less than $75.

Despite its modest cost, it offers automatic direct digital measurement over a wide range for both capacitance

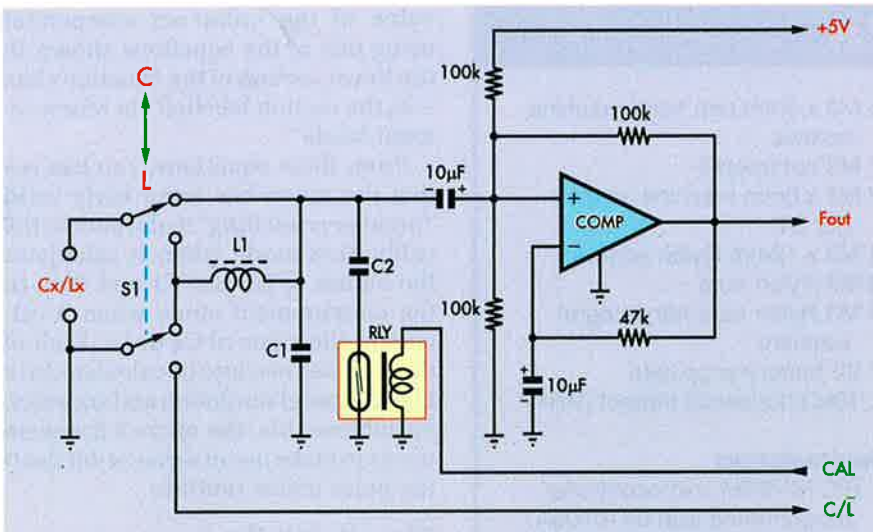


Fig.1: the circuit uses a wide-range test oscillator, the frequency of which varies when an unknown inductor (Lx) or capacitor (Cx) is connected. This oscillator is in turn monitored using a microcontroller which accurately calibrates the unit and measures the change in oscillator frequency. The microcontroller then calculates the unknown component's inductance or capacitance and displays the result on an LCD.

HOW IT WORKS: THE EQUATIONS

(A) In calibration mode

(1) With just L1 and C1: $F1 = \frac{1}{2.\pi.\sqrt{L1.C1}}$

(2) With C2 added to C1: $F2 = \frac{1}{2.\pi.\sqrt{L1.(C1+C2)}}$

(3) From (1) and (2), we can find C1:

$$C1 = \frac{F2^2}{(F1^2 - F2^2)} \bullet C2$$

(4) Also from (1) and (2), we can find L1:

$$L1 = \frac{1}{4.\pi^2.F1^2.C1}$$

(B) In measurement mode

(5) When Cx is connected: $F3 = \frac{1}{2.\pi.\sqrt{L1.(C1+Cx)}}$

so $Cx = C1 \bullet \left(\frac{F1^2}{F3^2} - 1\right)$

(6) Or when Lx is connected:

$$F3 = \frac{1}{2.\pi.\sqrt{(L1+Lx).C1}}$$

so $Lx = L1 \bullet \left(\frac{F1^2}{F3^2} - 1\right)$

NOTE: F2 & F3 should always be lower than F1

(C) and inductance (L) with 4-digit resolution. In fact, it measures capacitance from just 0.1pF up to 800nF and inductance from 10nH to 70mH. Measurement accuracy is also surprisingly good, at better than ±1% of reading.

It also operates from 9-12V DC, drawing an average current of less than 20mA. This means that it can be powered from either a 9V alkaline battery inside the case or from an external plugpack supply.

How it works

The meter's impressive performance depends on an ingenious measurement technique which was developed about 10 years ago by Neil Hecht, of Washington state in the USA. It uses a wide-range test oscillator whose frequency is varied by connecting the unknown inductor or capacitor you're measuring. The resulting change in frequency is measured by a microcontroller which then calculates the component's value and displays it directly on an LCD readout.

So there are basically only two key parts in the meter: (1) the test oscillator itself and (2) the microcontroller which measures its frequency (with and without the component being measured) and calculates the component's value.

To achieve reliable oscillation over a wide frequency range, the test oscillator is based on an analog comparator with positive feedback around it – see Fig.1. This configuration has a natural inclination to oscillate because of the very high gain between the comparator's input and output.

When power (+5V) is first applied, the comparator's non-inverting (+) input is held at half the supply voltage (+2.5V) by a bias divider formed by two 100kΩ resistors. However, the voltage at the inverting input is initially zero because the 10µF capacitor at this input needs time to charge via the 47kΩ feedback resistor. So with its non-inverting input much more positive than its inverting input, the comparator initially switches its output high (ie, to +5V).

Once it does so, the 10µF capacitor on the inverting input begins charging via the 47kΩ resistor and so the voltage at this input rises exponentially. As soon as it rises slightly above the +2.5V level, the comparator's output suddenly switches low.

This voltage low is fed back to the comparator's non-inverting input via a 100kΩ feedback resistor. It is also coupled through the 10µF input capacitor to a tuned circuit formed by inductor L1 and capacitor C1. This makes the tuned circuit "ring" at its resonant frequency.

As a result, the comparator and the tuned circuit now function as an oscillator at that resonant frequency. In effect, the comparator effectively functions as a "negative resistance" across the tuned circuit, to cancel its losses and maintain oscillation.

Once this oscillation is established, a square wave of the same frequency appears at the comparator's output and it is this frequency (F_{out}) that is measured by the microcontroller. In practice, before anything else is con-

Specifications

- **Inductance Range:** from about 10nH to over 70mH (4-digit resolution)
- **Capacitance Range:** from about 0.1pF to over 800nF (4-digit resolution)
- **Range Selection:** automatic (capacitors must be non-polarised)
- **Sampling Rate:** approximately five measurements per second
- **Expected Accuracy:** better than ±1% of reading, ±0.1pF or ±10nH
- **Power Supply:** 9-12V DC at less than 20mA (non-backlit LCD module). Can be operated from an internal 9V battery or an external plugpack.

Parts List

1 PC board, code 04105081, 125 x 58mm
1 PC board, code 04105082, 36 x 16mm
1 PC board, code 04105083, 41 x 21mm
1 UB3 utility box, 130 x 68 x 44mm
1 16x2 LCD module (Jaycar QP-5515 or QP-5516 – see panel)
1 5V 10mA DIL reed relay (Jaycar SY-4030)
1 100µH RF inductor (L1)
1 4.0MHz crystal, HC-49U
1 DPDT subminiature slider switch (S1)
1 SPST momentary contact pushbutton switch (S2)
1 SPDT mini toggle switch (S3)
1 18-pin DIL IC socket
1 2.5mm PC-mount DC connector
1 4x2 section of DIL header strip
1 7x2 section of DIL header strip
1 jumper shunt
1 binding post/banana socket, red
1 binding post/banana socket, black
2 PC terminal pins, 1mm diameter
4 M3 x 15mm tapped spacers
4 M3 x 6mm csk head machine screws
5 M3 x 6mm pan head machine screws
1 M3 nut (metal)
2 M2 x 6mm machine screws (for S1)
4 M3 x 12mm Nylon screws
8 M3 Nylon nuts
4 M3 Nylon nuts with integral washers
1 9V battery snap lead
1 10kΩ horizontal trimpot (VR1)

Semiconductors
1 PIC16F628A microcontroller programmed with 0410508A.hex (IC1)
1 7805 +5V regulator (REG1)
1 1N4148 diode (D1)
1 1N4004 diode (D2)

Capacitors
1 22µF 16V RB electrolytic
2 10µF 16V RB electrolytic
1 10µF 16V tantalum
1 100nF monolithic
2 1nF MKT or polystyrene (1% if possible)
2 33pF NPO ceramic

Resistors (0.25W, 1%)
3 100kΩ 2 4.7kΩ
1 68kΩ 4 1kΩ
1 47kΩ

nected into circuit, F_{out} simply corresponds to the resonant frequency of L1, C1 and any stray capacitance that may be associated with them.

When power is first applied to the meter, the microcontroller measures this frequency (F1) and stores it in memory. It then energises reed relay RLY1, which switches capacitor C2 in parallel with C1 and thus alters the oscillator frequency (ie, it lowers it). The microcontroller then measures and stores this new frequency (F2).

Next, the microcontroller uses these two frequencies plus the value of C2 to accurately calculate the values of both C1 and L1. If you're interested, the equations it uses to do this are shown in the top (Calibration Mode) section of the box titled "How It Works: The Equations".

Following these calculations, the microcontroller turns RLY1 off again to remove C2, allowing the oscillator frequency to return to F1. The unit is now ready to measure the unknown inductor or capacitor (Cx or Lx).

As shown in Fig.1, the unknown component is connected across the test terminals. It is then connected to the oscillator's tuned circuit via switch S1. When measuring an unknown capacitor, S1 is switched to the "C" position so that the capacitor is connected in parallel with C1. Alternatively, for an unknown inductor, S1 is switched to the "L" position so that the inductor is connected in series with L1.

In both cases, the added Cx or Lx again causes the oscillator frequency to change, to a new frequency (F3). As with F2, this will always be lower than F1. So by measuring F3 as before and monitoring the position of S1 (which is done via the C/L-bar line), the microcontroller can calculate the value of the unknown component using one of the equations shown in the lower section of the equations box – ie, the section labelled "In Measurement Mode".

From these equations, you can see that the micro has some fairly solid "number crunching" to do, both in the calibration mode when it calculates the values of L1 and C1 and then in the measurement mode when it calculates the value of Cx or Lx. Each of these values needs to be calculated to a high degree of resolution and accuracy. To achieve this, the micro's firmware needs to make use of some 24-bit floating point maths routines.

Circuit details

How this ingenious yet simple measurement scheme is used to produce a practical LC meter can be seen from the full circuit diagram of Fig.2. It's even simpler than you might have expected because there's no separate comparator to form the heart of the measurement oscillator. Instead we're making use of a comparator that's built into the microcontroller (IC1) itself.

As shown, microcontroller IC1 is a PIC16F628A and it actually contains two analog comparators which can be configured in a variety of ways. Here we are using comparator 1 (CMP1) as the measurement oscillator. Comparator 2 (CMP2) is used only to provide some additional "squaring up" of the output from CMP1 and its output then drives the internal frequency counting circuitry.

The oscillator circuitry is essentially unchanged from that shown in Fig.1. Note that the micro controls RLY1 (which switches calibrating capacitor C2 in and out of circuit) via its I/O port B's RB7 line (pin 13). Diode D1 prevents the micro's internal circuitry from being damaged by inductive spikes when RLY1 switches off.

In operation, IC1 senses which position switch S1 is in using RB6 (pin 12). This is pulled high internally when S1b is in the "C" position and low when S1b is in the "L" position. Crystal X1 (4MHz) sets the clock frequency for IC1, while the associated 33pF capacitors provide the correct loading to ensure reliable starting of the clock oscillator.

The results of IC1's calculations are displayed on a standard 2x16 line LCD module. This is driven directly from the micro itself, via port pins RB0-RB5.

Trimpot VR1 allows the LCD contrast to be optimised.

Firmware & link functions

The firmware in IC1 is designed to automatically perform the calibration function just after initial start-up. However, this can also be performed at any other time using switch S2. Pressing this switch simply pulls the micro's MCLR-bar pin (4) down, so that the micro is forced to reset and start up again, recalibrating the circuit in the process.

Links LK1-LK4 are not installed for normal use but are used for the initial setting up, testing and calibration. As shown, these links connect between RB3-RB0 and ground respectively.

For example, if you fit LK1 and then press S2 to force a reset, the micro will activate RLY1 (to switch capacitor C2 into circuit) and measure oscillator frequency F2. This is then displayed on the LCD.

Similarly, if you fit LK2 and press S2, the micro simply measures the initial oscillator frequency (F1) and displays this on the LCD. This allows you to not only make sure that the oscillator is operating but you can check its frequency as well. We'll have more to say about this later.

LK3 & LK4 allow you to perform manual calibration "tweaks" to the meter. This is useful if you have access to a capacitor whose value is very accurately known (because it has been measured using a full-scale LCR meter, for example).

With LK3 fitted, the capacitance reading decreases by a small amount each time it makes a new measurement (which is about five times per second). Conversely, if LK4 is fitted instead, the microcontroller increases the capacitance reading by a small increment each time it performs a new measurement.

Each time a change is made, the adjustment factor is stored in the micro's EEPROM and this calibration value is then applied to future measurements. Note also that although the calibration is made using a "standard" capacitor, it also affects the inductance measurement function.

In short, the idea is to fit the jumper to one link or the other (ie, to LK3 or LK4) until the reading is correct. The link is then removed.

As mentioned above, links LK1-LK4 are all left out for normal operation.

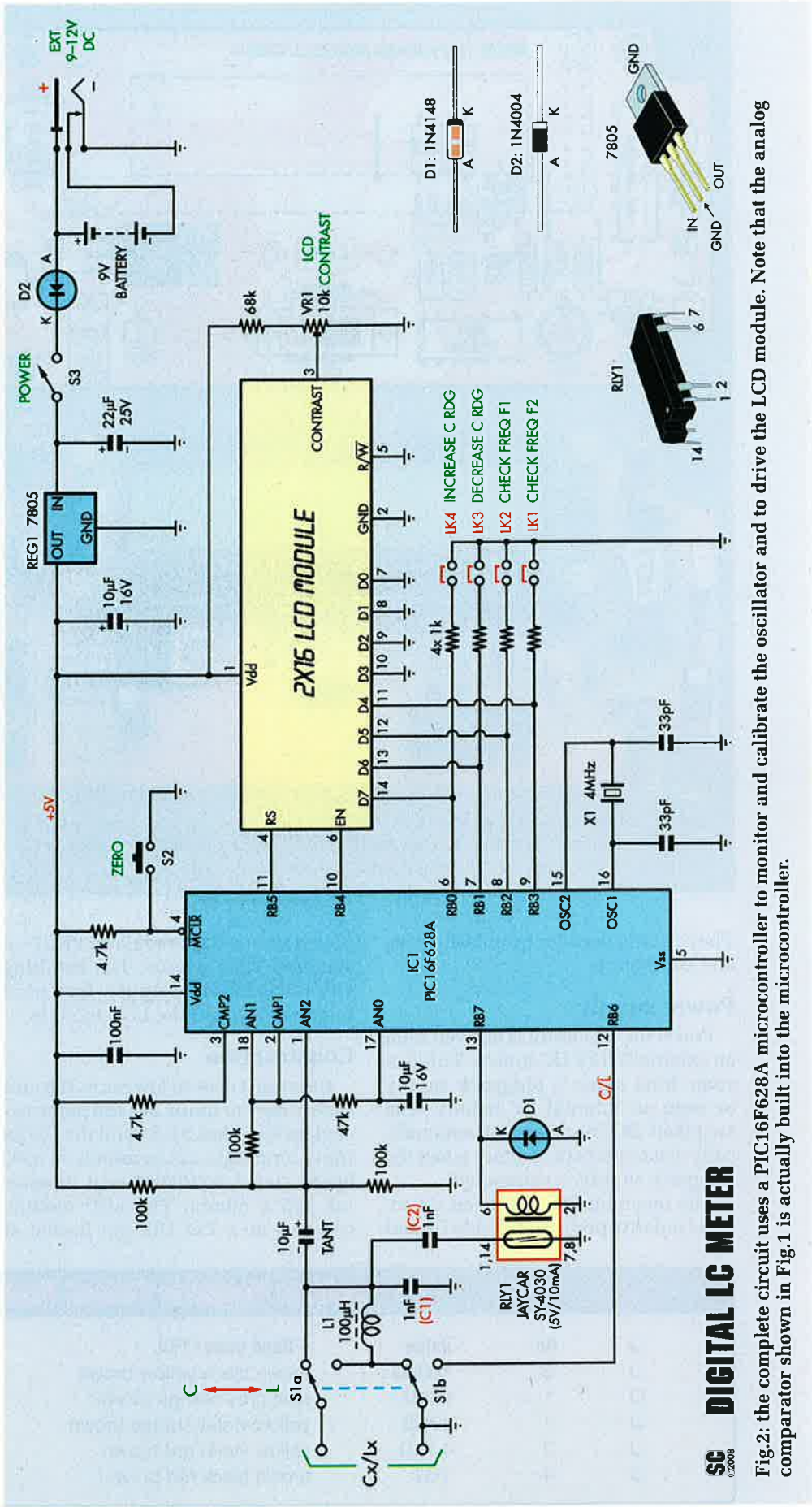


Fig.2: the complete circuit uses a PIC16F628A microcontroller to monitor and calibrate the oscillator and to drive the LCD module. Note that the analog comparator shown in Fig.1 is actually built into the microcontroller.

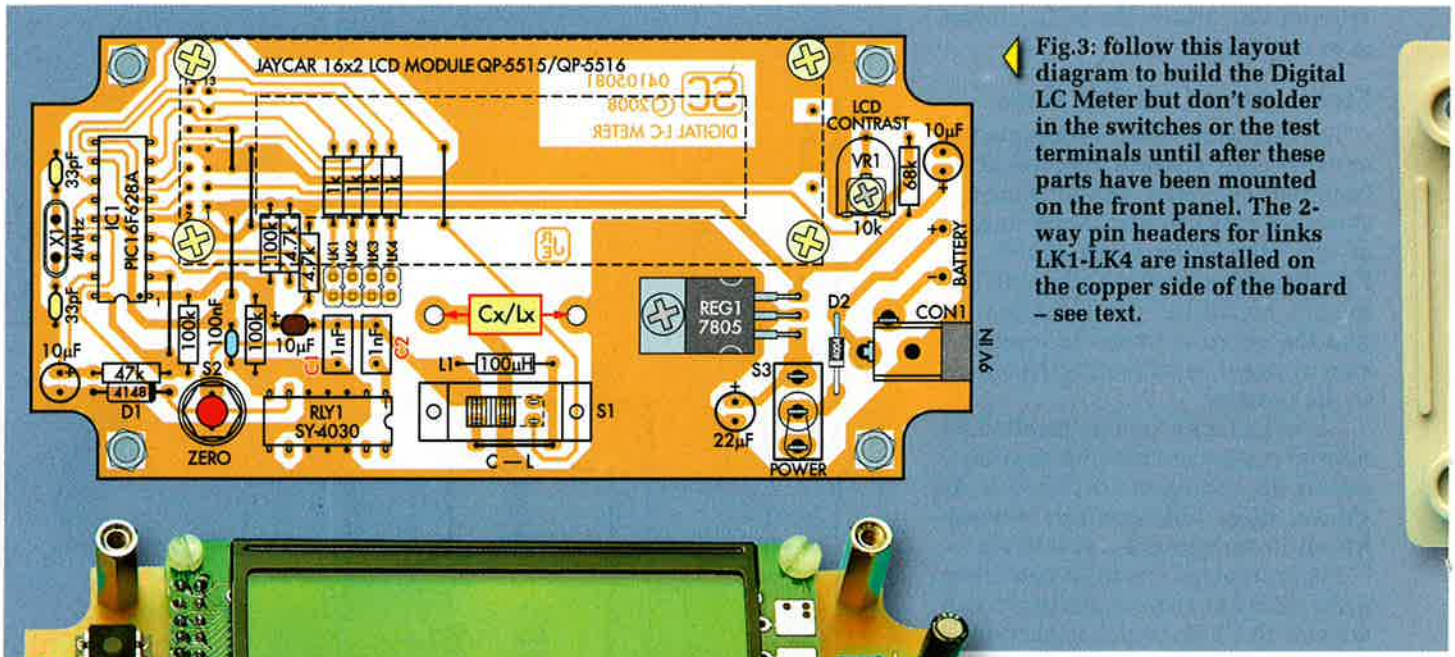
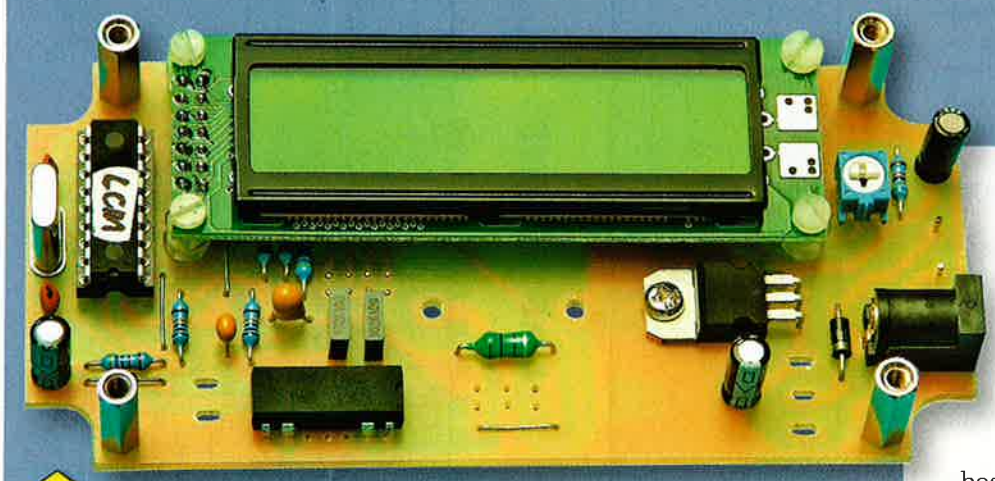


Fig.3: follow this layout diagram to build the Digital LC Meter but don't solder in the switches or the test terminals until after these parts have been mounted on the front panel. The 2-way pin headers for links LK1-LK4 are installed on the copper side of the board – see text.



The PC board assembly is attached to the case lid using M3 x 15mm spacers and M3 x 6mm csk-head machine screws. Make sure that the assembly is secure before soldering the switch lugs and test terminals.

They're only used for troubleshooting and calibration.

Power supply

Power for the circuit is derived from an external 9-12V DC source. This can come from either a plugpack supply or from an internal 9V battery. The switched DC input socket automatically disconnects the battery when the plugpack supply is connected.

The incoming DC rail is fed via reverse polarity protection diode D2 and power switch S3 to regulator REG1 – a standard 7805 device. The resulting +5V rail at REG1's output is then used to power IC1 and the LCD module.

Construction

Because it uses so few parts, the unit is very easy to build. All the parts, except for switches S1-S3 and the Cx/Lx input terminals, are mounted on a PC board coded 04105081 and measuring 125 x 58mm. The LCD module connects to a 7x2 DIL pin header at one end of the board and is supported at either end using M3 Nylon screws and nuts.

Fig.3 shows the parts layout on the PC board. Here's the suggested order of fitting the components to the PC board:

(1). Fit DC power connector CON1 and the two 1mm PC board terminal pins for the internal battery connections.

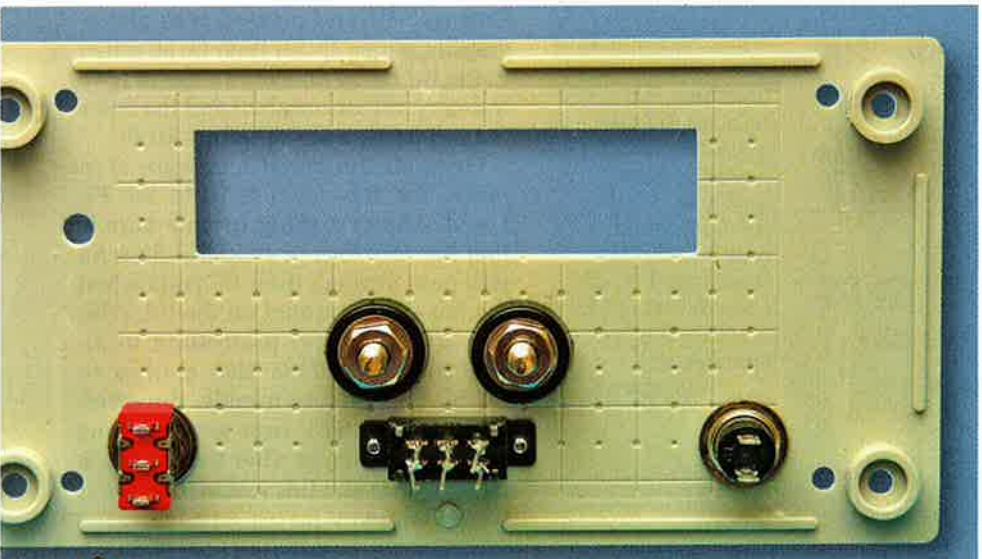
(2). Fit the six wire links, four of which go under where the LCD module is later fitted. Don't forget the link immediately below switch S1.

(3). Install the 4x2 DIL pin header used for links LK1-LK4. **Note that this item must be mounted on the copper side of the board (not on the top),** so that a jumper can later be fitted to any of the links when the board assembly is attached to the box lid).

To install this header, just push the ends of the longer sides of the pins into the board holes by 1-2mm, then solder them carefully to the pads. That done, push the plastic strip down the pins so that it rests against the solder joints,

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	3	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	68kΩ	blue grey orange brown	blue grey black red brown
❑	1	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	2	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	4	1kΩ	brown black red brown	brown black black brown brown



This view shows the back of the case lid before the PC board assembly is attached. Note the "extension leads" soldered to slide switch S1's terminals.

leaving the clean outer ends of all pins free to take a jumper shunt.

(4). Fit a 7x2 DIL pin header for the LCD module connections. This header is fitted to the top of the PC board in the usual way.

(5). Install the 11 resistors, seven of which go under the LCD module. Table 1 shows the resistor colour codes but you should also check each resistor using a DMM before soldering it to the board.

(6). Install trimpot VR1, followed by inductor L1 and reed relay RLY1.

(7). Fit the five non-polarised capacitors, followed by the 10µF tantalum, the two 10µF RB electrolytics and the 22µF RB electrolytic. Note that the tantalum capacitor and the electrolytics are polarised, so take care with their orientation.

(8). Install relay RLY1, the 18-pin socket for IC1 and the 4MHz crystal X1. Follow these parts with diodes D1 & D2 and regulator REG1.

Note that the regulator's leads are bent downwards through 90° 6mm from its body, so that they pass through the holes in the board. Before soldering its leads, secure its metal tab to the PC board using an M3 x 6mm machine screw and nut.

(9). Secure the LCD module to the PC board, using four M3 x 12mm cheesehead Nylon screws and 12 nuts (three on each screw). Fig.4 shows the details.

At each mounting point, two plain nuts act as spacers between the module and the PC board, while a third nut with an integral washer is fitted to secure the assembly under the PC board. Note that when you're fitting the module to the top of the board, it should be lowered carefully so that the holes at the lefthand end slip down over the pins of the 7x2 DIL strip fitted earlier.

Table 2: Capacitor Codes

Value	µF Code	IEC Code	EIA Code
100nF	0.1µF	100n	104
1nF	.001µF	1n	102
33pF	NA	33p	33

(10). Solder the 14 pin connections on the top of the LCD module using a fine-pointed iron.

(11). Plug the programmed PIC-16F628A (IC1) into its socket, then fit four M3 x 15mm tapped spacers to the PC board mounting points. Secure these spacers using M3 x 6mm pan-head screws.

That completes the board assembly. It can now be placed to one side while you work on the case.

Preparing the case

As shown in the photos, the PC board assembly is mounted on the lid of a standard UB3-size jiffy box.

If you're building the Digital LC Meter from a kit, the plastic case will probably be supplied with all holes drilled and with screen printed letter-

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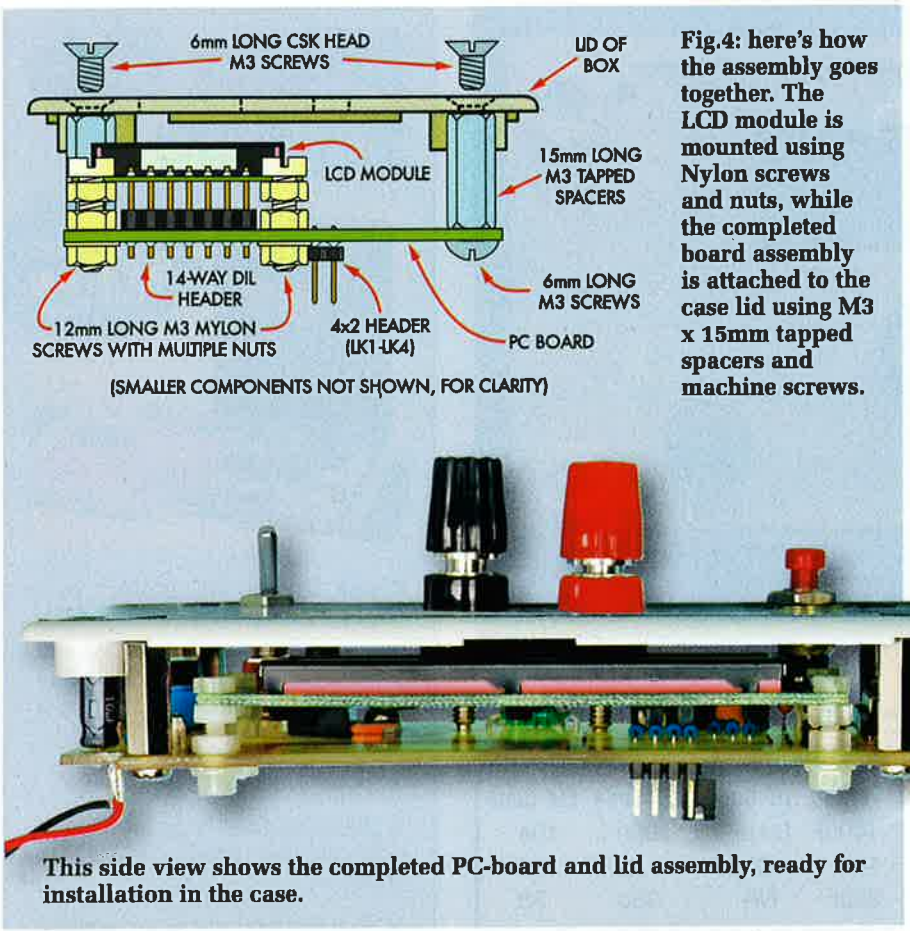

6mm LONG CSK HEAD M3 SCREWS
LID OF BOX
LCD MODULE
15mm LONG M3 TAPPED SPACERS
14-WAY DIL HEADER
6mm LONG M3 SCREWS
12mm LONG M3 MYLON SCREWS WITH MULTIPLE NUTS
4x2 HEADER (LK1-LK4)
PC BOARD
(SMALLER COMPONENTS NOT SHOWN, FOR CLARITY)

Fig.4: here's how the assembly goes together. The LCD module is mounted using Nylon screws and nuts, while the completed board assembly is attached to the case lid using M3 x 15mm tapped spacers and machine screws.

This side view shows the completed PC-board and lid assembly, ready for installation in the case.

ing for the front panel. If so, it will be simply a matter of fitting the switches and binding posts to the lid.

Note that slide switch S1 is secured using two M2 x 6mm machine screws, while S2 & S3 are mounted using their own mounting nuts and lockwashers. The binding posts mount to the panel in the same way.

If you have to drill the case holes yourself, you can use a copy of the front panel artwork as a drilling template. In addition, you will have to drill/ream a 10mm diameter hole in the righthand end of the box to give access to the DC connector (CON1). This hole should be positioned 22mm from the front edge of the case and 9mm down from the lid, so that it aligns correctly with CON1.

That done, the front panel artwork can be downloaded from the SILICON CHIP website and printed onto photographic paper. It can then be attached to the lid using an even smear of neutral-cure silicone sealant and the holes cut out using a sharp hobby knife.

Once all the panel hardware is in place, the next step is to fit the PC board. The first thing to note here is that the rear lugs of switches S2 & S3 will pass through their PC pads when the board is mounted on the lid, with just enough metal protruding to allow soldering. This also applies to the binding post terminals. **However, slide switch S1's lugs are not long enough for this, so after the switch is mounted on the lid, a short length of tinned copper wire (eg, a resistor lead offcut) must be soldered to each lug to extend its length.**

By the way, when you're fitting these short extension wires, it's a good idea to make a small hook at the end of each wire and pass it through the lug's hole before squeezing it with needle-nose pliers. The idea here is to ensure that, once soldered, it's not going to fall out when the lower ends of the wires are later soldered to the board pads.

Once the extension wires have been fitted, you should be able to fit the PC board assembly on the lid so that all the switch and binding post leads pass through their matching board holes. That done, you can fasten it all together using four M3 x 6mm countersink head screws which pass through the front of the lid and into the spacers.

The assembly can now be completed by soldering the switch and binding post leads and by fitting the battery snap connector.

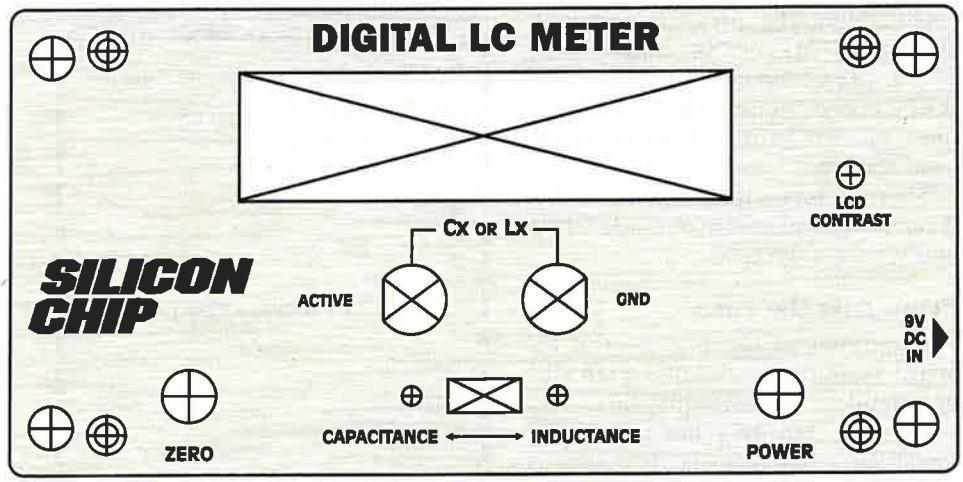


Fig.5: this full-size front-panel artwork can be used as a drilling template for the front panel. The artwork is also on the SILICON CHIP website.

Checkout & calibration

Your LC Meter is now ready for testing and calibration. To do this, first connect a plugpack supply or a 9V alkaline battery to the unit, set slider switch S1 to the "Capacitance" position and switch on using S3. As soon as power is applied, the message "Calibrating" should appear on the LCD for a second or two, then the display should change to read "C = NN.N pF", where NN.N is less than 10pF.

If this happens, then your meter is probably working correctly, so just leave it for a minute or two to let the test oscillator stabilise. During this time the capacitance reading may vary slightly by a few tenths of a picofarad

Fig.6: this is what appears on the LCD screen after zeroing the unit in capacitance mode.

as everything settles down – that's normal.

Now press "Zero" button S2 for a second or two and release it. This forces the microcontroller to start up again and recalibrate, so you'll briefly see the "Calibrating" message again and then "C = 0.0pF". This indicates that the microcontroller has balanced out the stray capacitance and reset its zero reference.

Troubleshooting

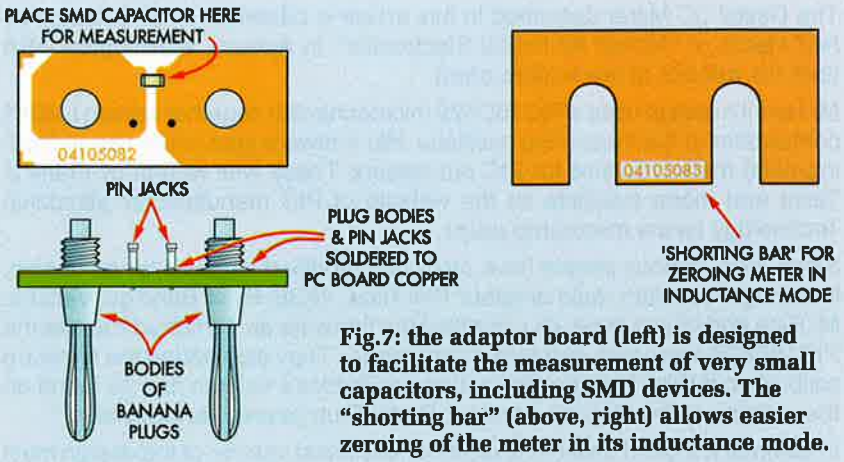
If you don't get any messages displayed on the LCD, chances are that you've connected either the battery snap lead or the plugpack lead's connector with reversed polarity. Check the supply connections carefully. With power applied, you should be able to measure +5V on pin 14 of IC1 with respect to ground.

Alternatively, if you get some messages on the LCD but they're not as described, it's time to check that the meter's test oscillator is working properly. To do this, switch off, fit jumper shunt LK2 (ie, at the back of the board), then apply power and watch the LCD. After the "Calibrating" message, the micro should display an 8-digit number which represents the oscillator frequency F1. This should be between about 00042000 and 00058000, if your components for L1 and C1 are within the usual tolerance.

If the figure you get for F1 is "00000000", your test oscillator isn't working and you will need to switch off and look for the cause. The possibilities include missed solder joints, a poor solder joint involving one of the oscillator components, or perhaps a tiny sliver of solder bridging adjacent tracks or pads.

If you do get a figure in the correct range, write the value down, then switch off and transfer the jumper shunt to the LK1 position. Re-apply power and check that the LCD now shows a different 8-digit number after calibrating. This will be F2 – ie, the

Adaptor Board For Very Small Capacitors


PLACE SMD CAPACITOR HERE FOR MEASUREMENT
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04105083
'SHORTING BAR' FOR ZEROING METER IN INDUCTANCE MODE

Fig.7: the adaptor board (left) is designed to facilitate the measurement of very small capacitors, including SMD devices. The "shorting bar" (above, right) allows easier zeroing of the meter in its inductance mode.

TO HELP MEASURE very small capacitors – including trimmers and SMD capacitors – we have designed a small adaptor board which can be plugged into the meter's binding post terminals. This adaptor board provides a pair of closely spaced pin jacks, along with copper pads separated by a 1mm gap.

The pin jacks make it easier to measure small leaded capacitors and very small trimmers, while the copper pads alongside are for measuring SMD capacitors.

The adaptor board is easily assembled. It mounts *copper-side-up* on two banana plugs, which are soldered to the copper around the two large holes. That done, the two pin jacks (cut from a SIL or DIL socket strip) are soldered into the two smaller holes.

To use this adaptor board, you simply plug it into the top of the Digital LC Meter's binding posts and then press the Zero button to force the meter to cancel out the additional stray capacitance. You can then measure small leaded capacitors, trimmers or SMD capacitors simply by applying them to the top of the adaptor.

Finally, we have also designed a second small adaptor board which acts a "shorting bar". It connects between the two normal binding posts of the Digital LC Meter, to allow zeroing of the meter in its inductance mode.

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Acknowledgements

The Digital LC Meter described in this article is based on a 1998 design by Neil Hecht of "Almost All Digital Electronics", in Auburn, Washington USA (see his website at **www.aade.com**).

Mr Hecht's design used a PIC16C622 microcontroller, together with an LM311 comparator in the measuring oscillator. His firmware also made use of floating-point maths routines for PIC processors. These was written by Frank J. Testa and made available on the website of PIC manufacturer Microchip Technology (**www.microchip.com**).

Since then, various people have produced modified versions of the design, including Australian radio amateur Phil Rice, VK3BHR of Bendigo, Victoria. Mr Rice and others have also modified the firmware and adapted it to use the PIC16F628 micro with its internal comparator. They also added the firmware calibration facility. Further information on Mr Rice's version can be found on the website of the Midland Amateur Radio Club (**www.marc.org.au**).

In summary, a great deal of the credit for this latest version of the design must go to those earlier designers. The author acknowledges their work.

oscillator frequency when capacitor C2 is switched in parallel with C1.

Because the two capacitors are nominally the same value, F2 should be very close to 71% of F1. That's because doubling the capacitance reduces the frequency by a factor equal to the square root of two (ie, $1/\sqrt{2} = 0.707$). If your reading for F2 is well away from 71% of F1, you may need to replace C2 with another capacitor whose value is closer to C1.

On the other hand, if F2 is exactly the same as F1, this suggests that RLY1 is not actually switching C2 in at all. This could be due to a poor solder joint on one of RLY1's pins or you may have wired it into the board the wrong way around.

Once you do get sensible readings for F1 and F2, your Digital LC Meter will be ready for calibration and/or use. If you don't have a capacitor of known value to perform your own accurate calibration, you'll have to rely on the meter's own self-calibration (which relies largely on the accuracy of capacitor C2). In this case, just remove any jumpers from LK1-LK4 and fit your meter assembly into its box, using the self-tapping screws provided to hold everything together.

The battery sits in the bottom of the case. It is secured by wrapping it in foam, so that it is firmly wedged in place when the lid assembly is fitted.

Using A Backlit LCD

Either the Jaycar QP-5515 LCD module (no backlight) or the QP-5516 LCD module (with backlight) can be used with this project.

If you intend running the unit from a plugpack or if battery use will only be for short periods, then the backlit QP-5516 can be used. Alternatively, for general battery use, we recommend the QP-5515 – its current consumption is much lower and so the battery will last a lot longer.

Fine-tuning the calibration

If you do have a capacitor of known value (because you've been able to measure it with a high-accuracy LCR meter), you can easily use it to fine-tune the Digital LC Meter's calibration.

First, switch the unit on and let it go through its "Calibrating" and "C = NN.N pF" sequence. That done, wait a minute or two and press the Zero button, ensuring that the LCD then shows the correctly zeroed message – ie, "C = 0.0 pF".

Next, connect your known-value capacitor to the test terminals and note the reading. It should be fairly close to the capacitor's value but may be somewhat high or low.

If the reading is too low, install LK4 on the back of the board and watch the LCD display. Every 200ms or so, the reading will increment as the PIC microcontroller adjusts the meter's scaling factor in response to the jumper. As soon as the reading reaches the correct figure, quickly remove the jumper to end the calibration adjustment.

Conversely, if the meter's reading for the known capacitor is too high, follow the same procedure but with the jumper in the LK3 position. This will cause the micro to decrement the meter's scaling factor each time it makes a measurement and as before, the idea is to remove LK3 as soon as the reading reaches the correct figure.

If you are not fast enough in removing the jumper during either of these calibration procedures, the microcontroller will "overshoot". In that case, you simply need to use the opposite procedure to bring the reading back to the correct figure. In fact, you may need to adjust the calibration back and forth a few times until you satisfied that it is correct.

As previously mentioned, the PIC microcontroller saves its scaling factor in its EEPROM after every measurement during these calibration procedures. That means that you only have to do the calibration once. Note also when you calibrate the meter in this way using a known value capacitor, it's also automatically calibrated for inductance measurements.

Using it

The Digital LC Meter is easy to use. Initially, you just switch it on, set S1 to "Capacitance" (NOT "Inductance"), wait a minute or two for it to stabilise and then zero it using pushbutton S2. It's then just a matter of connecting the unknown component to the test terminals, selecting "Capacitance" or "Inductance" using S1 and reading the component's value off the LCD.

Alternatively, you can zero the Digital LC Meter on the "Inductance" range by fitting the shorting bar shown in Fig.7 (since this bar has virtually zero inductance). This shorting bar is initially connected between the test terminals and switch S2 then pressed to zero the reading. That done, the shorting bar is removed and the unknown inductor connected to the test terminals.

Note that if you don't have S1 (Capacitance/Inductance) in the correct position, the micro will usually give an "Over Range" error message on the LCD. This will also occur if the component's value is outside the meter's measuring range – ie, above about 800nF for capacitors or 70mH for inductors.

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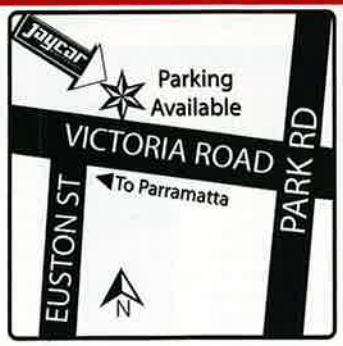

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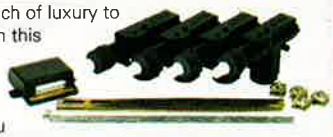

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$12.95

Two Port Video Splitter

Displays the computer's video signal on two monitors. Great for small presentations, education, and remote monitoring etc.

- Input 15 pin D male
- Outputs 15 pin D female

4 Port Video Splitter $99.95
Cat YN-8099 also available

Cat. YN-8098
$79.95

Remote or PC Controlled Moving Message Display

Display specials, opening hours, or just the time of day with this attention-getting display. It can be programmed with its remote control or via the RS-232 interface. Software & RS-232 cable included.

- Wall mounting
- 50 x 7 LED dot matrix
- 435(L) x 97(H) x 37(D)mm

Cat. XC-0193
$169.95

Network Cable Tracer

This tone generator is a highly practical network installation and troubleshooting tool and allows cables to be easily traced by the probe, even when cables are in a bundle or hidden in punch down blocks or wall plates.

Was $99

SAVE $20

Cat. XC-5083
$79

In-Desk 4 Port USB 2.0 Hub

NEW

This unique USB hub is built into a 3" desk grommet and provides an elegant solution for your desk top expansion. The hub has 4 x USB 2.0 ports and supports data transfer rates up to 480Mbps while the grommet section allows easy access to cables under your workstation. 3" hole diameter.

Cat. XC-4863
$19.95

NEW USB Greenhouse

No green thumb? Simply sow your seeds of choice, install the software, plug into your USB port and let your computer do all the work. Growth chart, calendar and diary functions not only remind you to water and fertilise but also help you monitor your plants progress.

- Marigold seeds, artificial soil and software included
- 220(H) x 170(W)mm
- Computer not included

Cat. GE-4097
$49.95

Digital Mobile Microscope

Enter the micro realm with ease. These portable pocket-sized microscopes are surprisingly powerful with a magnification range of 24x - 90x. They use 3 bright-white LEDs to light up your objects and feature an adjustable focus to sharpen your image. Two versions available:

Digital Mobile Microscope
Cat No. QC-3245
Dimensions: 120(L) x 55(W)mm

Digital Mobile Microscope with Image Capture
Cat no. QC-3246
Viewed images can be easily transferred to a PC (QC-3246 only) for use in reports, articles, projects etc. (Capable of taking JPEG images at a resolution of 320 x 240).

- Dimensions: 120(L) x 55(W)mm
- Includes 3 x AAA rechargeable Ni-MH batteries

Cat. QC-3245
$249

Cat. QC-3246
$299

USB Optical Mouse

This USB computer mouse has an ergonomic design to comfortably fit into your hand. It has a rubber paint finish for better overall grip and feel, which is matched with an optical pick up with 800dpi resolution for precision control.

- USB interface - Plug and Play
- Compatible with Win 95/98/2000/NT/ME/XP

Cat. XM-5131
$14.95

USB SIM Card Reader / Writer

This super small GSM SIM card reader is no larger than a keyring and allows you to read, write and edit all information stored on the card using your PC.

Cat. XC-5102
$34.95

Wireless Colour LCD Weather Station

Wireless outdoor temperature and hygrometer sensors transmit data to the colour LCD receiver which displays temperature, humidity, heat index & dew point levels, the time, barometric pressure and comfort index, and forecasts the weather through 5 weather icons.

- Outdoor sensors require 5 x AAA batteries (Use SB-2334)
- Plugpack for main unit included
- Dimensions: 170(L) x 95(H) x 50(D)mm (including stand)

Cat. XC-0342 **$149.95**

PIC Based Water Tank Level Meter Kit

Ref Silicon Chip November 2007

NOW IN STOCK

This PIC-based unit uses a pressure sensor to monitor water level and will display tank level via an RGB LED at the press of a button. The kit can be expanded to include an optional wireless remote display panel that can monitor up to ten separate tanks (KC-5461) or you can add a wireless remote controlled mains power switch (KC-5462) to control remote water pumps. Kit includes electronic components, case, screen printed PCB & pressure sensor.

KC-5461 Remote Display Kit $79.95
KC-5462 UHF Remote Controlled Mains Switch $99.95

Cat. KC-5460 **$99.95**

KC-5461

KC-5462

Digital Hand-Held Anemometer

A handy tool for the sailor or windsurfer or the everyday enthusiast. Measure the speed of wind in mph, km/h, m/s or knots, displayed on an LED display with a Beaufort wind scale bar graph.

- Battery included

Was $79.95

SAVE $15

Cat. QM-1640 **$64.95**

Rechargeable Spotlights

These versatile halogen spotlights feature a bright quartz halogen globe, swivel handle and adjustable stand for various carry or mounting positions, lever style power switch for hands-free use, all constructed into a high-impact ABS plastic, weatherproof body. The internal SLA battery can be charged through your car's cigarette lighter or by the supplied plugpack.

- Perfect for automotive, boating or other outdoor recreational use
- Supplied with mains and in-car charger
- Replacement globe available - use Cat. SL-3221

ST-3300 1,000,000 Candlepower
ST-3303 5,000,000 Candlepower
ST-3308 10,000,000 Candlepower

Cat. ST-3300 **$26.95** Cat. ST-3303 **$34.95** Cat. ST-3308 **$79.95**

38 Channel UHF CB Twin Pack

This 2 pack of mini UHF CB communicators can keep you clearly in touch up to 3km. They feature electronic volume control, monitor functions and an integrated blue LED torch.

- Requires 3 x AAA batteries per unit

Was $49.95

SAVE $10

Cat. QC-1005 **$39.95**

200 Watt Wind Turbine Generators

These are serious wind turbines at a breakthrough price. They will generate useful power at wind speeds as low as three metres per second (10kph) and deliver their rated output at around eight metres per second (28kph). Some skill is required in construction e.g. concreting, mechanical assemble and rigging etc. See our website or catalogue for full specifications. 12V and 24V models available. 80kg shipping weight.

MG-4512 12V model Cat. MG-4512 **$499.00**
MG-4510 24V model Cat. MG-4510 **$499.00**

The Amazing Flygun

Get rid of flies and other insect pests and have some fun at the same time. The kids will love it and so will you.

- Suitable for 8yrs+

Cat. YS-5545 **$7.95**

Dynamo Solar LED Torch

This compact green powered torch is great for camping and for the car. Just a few cranks on the handle and it will give you a super bright light consisting of 3 LEDs. Also features a solar panel to keep the torch charged and ready for use.

- Dimensions: 150(L) X 50(W) x 30(D)mm

Cat. ST-3345 **$24.95**

NEW

Amorphous Solar Panels

These amorphous silicon panels are made in Asia under the control of one of the largest US manufacturers and maintain good performance even on cloudy days. The panels have a strong aluminium frame and the cells are protected by a strong, clear glass window. They are long lasting and will maintain 80% of there performance rating, even after 20 years of use.

- Dual junction amorphous silicon with laser edged isolation construction

Voltage	Power	Cat.	Price
6V	1W	ZM-9020	$29.95
12V	2W	ZM-9024	$39.95
12V	4W	ZM-9026	$69.95
12V	10W	ZM-9030	$139.00
12V	15W	ZM-9045	$159.95
12V	40W	ZM-9034	$319.00

ZM-9045

ZM-9026 ZM-9024 ZM-9020

ZM-9034 Due mid June

ZM-9030

FOR INFORMATION AND ORDERING
TELEPHONE> 1800 022 888 INTERNET> www.jaycar.com.au

Economy Four Zone Wireless Alarm

EASY D.I.Y. PROJECT

An affordable system that provides reliable protection for your home, apartment or small office. The system is simple to install and the alarm panel will detect and 'learn' which sensors have been installed. The control unit also monitors the system status and sensor battery condition to ensure system reliability. The system includes the control panel with keypad, a passive IR motion sensor, and a reed switch sensor for door or window protection. Wireless installation makes the system ideal for tenants. Batteries and power supply included.

Cat. LA-5134
$99.95

Specifications:
- Control Unit • Transmission frequency - 433MHz
- Siren duration - 3 min
- Dimensions - 85(W) x 160 (H) x 30(D)mm

PIR Sensor
- Coverage - 110° •Detection range - up to 12 metres
- Power requirement - 2 x AAA batteries (Use SB-2426)

Reed Switch Sensor
- Power requirements - 2 x AAA batteries (Use SB-2426)

Additional Sensors available separately
LA-5136 - **Wireless PIR Sensor $49.95**
LA-5137 - **Wireless Reed Switch Sensor $39.95**
LA-5138 - **Remote Control Unit $29.95**
LA-5139 - **Repeater/Extender Sensor $59.95**

Video IP/Network Web Server - 2 Channel with PSU

Upgrade your CCTV system to an IP (Internet Protocol) surveillance system. The unit can be given a fixed, or router assigned IP address, which allows camera images to be viewed and controlled from anywhere in the world via an Internet browser.
See website for full details

Cat. QC-3394
$199

Garage Alarm with Dual Sensor

Simple to install and protects your valuable tools and equipment stored in the shed, garage or even the boat.
- Mains powered
- Controlled unit measures 80(W) x 120(H) x 32(D)mm

Cat. LA-5400
$49.95

Doorbell for the Hearing Impaired

When this doorbell rings, the sound is accompanied by bright flashes from the receiver's built in strobe light so a hearing impaired person will know that someone is at the door. Can be taken from room to room or used outdoors.
- Choose from seven melodies
- 210mm long
- Requires 4 x C cells (Use SB-2320)

Was **$49.95**

SAVE $10

Cat. LA-5002
$39.95

Portable Pan/Tilt Night Vision Camera System

This wireless, compact and versatile pan-tilt camera system is designed for general use around the home or office. The system can be used to monitor a sleeping child's bedroom or keep an eye on the kids playing in the back yard. It would also be useful as a simple surveillance system in a shop or office. The four channel monitor is small and compact and can be easily carried in your hand or pocket. The system also has audio capabilities so you can listen as well as see what is going on elsewhere. The monitor has both audio and video outputs that can be fed to a video recorder if desired. The monitor can support up to three cameras. Mains plug pack are provided for both the camera and monitor.

Camera Specifications
- 1/3 " CMOS image sensor
- 380 TV lines
- 62° viewing angle
- 5m night vision range

Was **$399.00**

SAVE $50

Cat. QC-3279
$349

Mini Personal Alarm

This tiny personal alarm has a loud 100dB (A) siren and is small enough to fit in your purse or around your neck. Batteries included.
- Measures: 40(L) x 25(W) x 16(H)mm

Cat. LA-5182
$9.95

Biometric Fingerprint ID Access Control

Control a single door or use multiple units on a site connected to a PC via an RS232, RS485 or Ethernet connection. Software included.
- Up to 500 users
- 12VDC 3A relay output
- Tamper and door ajar alarm outputs
- Requires 9VDC @ 500mA
- 180(L) x 82(W) x 55(H)mm

Cat. LA-5121
$499

Dual Beam Infrared Barrier

Dual beam detector for enhanced security. Housed in a strong aluminum housing and suitable for protected outdoor environments (IP55).
- Indoor sensing range 16m
- Mounting hardware included

Cat. LA-5186
$149

GSM Alarm Transmitter & Receiver

SAVE $100

g-smart is a GSM-based SMS transmitter/receiver control system. It is a simple yet powerful communications module and uses a dual-band Siemens TC35 GSM module to receive secure commands and messages. g-smart can be utilised as the heart of your home automation system. It has 2 on-board relays (expandable to 8) and can easily connect to eight different pieces of equipment such as an air conditioner, central heating system, or electric gates etc. Configuration settings are stored in the g-smart and are not lost in case of a power failure. If a break-in occurs or an alarm is triggered, the unit will send an SMS message or an email to a pre-defined account.

Cat. LA-5370
$499

The system uses caller ID and passwords to ensure that only authorised users can access the system.
Power supply: 12V-15V DC 8W
SIM card: Mini card, 1.8V & 3V
Measures: 82.5(H) x 94(L) x 28(D)mm
Was **$599.00**

g-smart application areas
Alarm systems for - automobiles, trucks, construction machinery, containers, caravans, holiday homes. Devices for monitoring vending machines (malfunction and stock warnings), refrigeration systems (temperature control), pumps (power failure). Remote controls for watering, heating, lighting, video surveillance, sirens or any household appliance..
• LA-5372 GSM Alarm Expander board $89.95

UHF Baby Monitor Transmitter

Know exactly when your baby is awake, needs changing or even feeding with our automatic baby transmitter. The voice activation (VOX) means you'll always hear the sounds in the baby's room. Works with any of our UHF transceivers up to 500 metres away. Includes keypad lock.

Cat. QC-1024
$69

Science Time Kits

A fantastic range of 25 electrical science kits that will give your children an insight into the wonderful world of science. Each kit is a project in itself and will help develop your child's scientific knowledge, and dexterity. Kits are supplied with almost everything you need to construct the project. Here's just a few examples.

Electromagnetic Playground

Construct an electromagnetic swing and see-saw while learning about magnetism.

- Base size 112(W) x 110(D) x 5(H)mm
- Requires 2 x AA batteries (Use SB-2424)
- 8yrs+

Cat. KJ-8852 **$9.95**

Balloon Racer Experiments

- Discover the concept of propulsion while building a racing car.
- Supplied with pump and 3 x balloons
- Car Size: 75(W) x 120(L) x 35(H)mm
- Suitable for ages 8yrs+

Cat. KJ-8860 **$9.95**

Robotic Bubble Blower

Build this automatic bubble blower device complete with gears and a liquid tank.

- Size 111(W) x 120(L) x 130(H)mm
- 8yrs+

Cat. KJ-8876 **$9.95**

Volcanic Eruption Kit Experiments

Find out why volcanoes erupt and how the pressure is derived from magma and gas.

- Supplied with goggles, chemicals and volcano cup
- 10yrs+

Cat. KJ-8896 **$9.95**

"Pre Champ" Versatile Preamplifier Kit

Refer Silicon Chip 07/94

This tiny preamp was specifically designed to be used with the 'Champ' amplifier KC-5152. Unless you have a signal of sufficient amplitude the 'Champ' will not produce its maximum power output. The 'Pre-Champ' is the answer with a gain in excess of 40dB, which is more than enough for most applications. You can vary the gain by changing a resistor and there is even provision on the PCB for an electret microphone. Use AM-4010.

Cat. KC-5166 **$7.95**

- Power requirement 6-12VDC
- Kit includes PCB and electronic components
- Can be battery powered

Crystal Radio

Enjoy AM broadcasting without using battery or other power sources. Ideal for entry-level students or hobbyist with little electronics experience. Includes circuit explanation. Kit supplied with silk-screened PCB (81x53mm), crystal, prewound coil, earphone and all components.

Cat. KV-3540 **$11.95**

3 Metre IR Light Beam

With a range of about 3 metres, this kit will indicate using an LED when a person or object interrupts the infrared light beam. Use it across a doorway or across an assembly line. Connect a relay or use the relay card KG-9142 for a relay output. PCB dimensions: 20 x 30mm. Kit supplied with Kwik Kit PCB, infrared transmitter/receiver diodes, magnifying lens and all electronic components. 9-12VDC operation - use plugpack Cat. MP-3011.

Cat. KG-9094 **$11.95**

LED Battery Voltage Indicator

Refer: Electronics Australia Sept 1995

This tiny circuit measures just 25mm x 25mm and will provide power indication and low voltage indication using a bi-colour LED, and can be used in just about any piece of battery operated equipment. Current consumption is only 3mA at 6V and 8mA at 10V and the circuit is suitable for equipment powered from about 6-30VDC. With a simple circuit change, the bi-colour LED will produce a red glow to indicate that the voltage has EXCEEDED a preset value.

- PCB, bi-colour LED and all specified electronic components supplied.

Cat. KA-1778 **$8.95**

USB Experimenter's Interface Kit

Interface your computer to the real world

- 5 digital inputs to monitor the state of external switches or controls
- Two variable gain analogue inputs that connect to sensors measuring temperature, humidity, voltage, current, & other variable parameters
- Eight digital & two analogue outputs for controlling external equipment. The kit is supplied with all components, silk screened PCB, assembly manual, and software
- On-board test buttons for inputs and LED
- PCB measures 145 x 87mm
- Analogue input range 0 to 5VDC
- USB powered
- Win98SE or above (not NT)

Cat. KV-3600 **$69.95**

Digital Multimeter Kit

Learn everything there is to know about component recognition and basic electronics with this comprehensive kit. From test leads to solder, everything you need for the construction of this meter is included. All you'll need is a soldering iron!

- Meter dimensions: 67(W) x 123(H) x 25(D)mm

Cat. KG-9250 **$19.95**

Economy Adjustable Temperature Switch

Ref: High Performance Electronic Projects for Cars - Silicon Chip Publications.

This unit has an adjustable switching temperature up to 245°C, and it can be configured to trigger with rising or falling temperature. It has adjustable hysteresis (the difference between on/off temp) which is a great feature many other units do not possess. It can be used to operate cooling fans on a radiator or amplifier, over-temp warning lights or alarms, and much more. The small temperature sensor reacts quickly to temp changes. Kit supplied with PCB, NTC Thermistor, and all electronic components.

Cat. KC-5381 **$29.95**

Tempmaster Kit

Ref: Silicon Chip June 2005

This project turns a regular fridge or freezer into a wine cooler by accurately controlling the temperature between 2.5 - 33° making it suitable for wine storage. Kit supplied with PCB , panel mount mains socket, mains lead, machined case with screen printed lid and all electronic components.

Cat. KC-5413 **$39.95**

Speedo Corrector MkII

Refer: Silicon Chip December 2006

Modifying your gearbox, diff ratio or tyre circumference, may result in an inaccurate speedometer. This kit alters the speedometer signal up or down from 0% to 99% of the original signal. With this improved model, the input setup selection can be automatically selected and it also features an LED indicator to show when the input signal is being received. Kit supplied with PCB with overlay and all electronic components.

Cat. KC-5435 **$49.95**

- Recommended box UB5 use HB-6015

FOR INFORMATION AND ORDERING
TELEPHONE> 1800 022 888 INTERNET> www.jaycar.com.au

Windows Media Centre Remote Control

A Windows Media Centre PC can revolutionise your home entertainment and this remote will put you in command. The remote will let you control the system as easily as you now control the TV.

- Requires 3 x AAA batteries
- 210mm long

Cat. XC-4889 **$24.95**

Home Theatre Powerboard

Surge protection and filtering are provided for the mains as well as your telephone line, network connection, satellite / cable TV, and the TV antenna. Further protection is provided by the built-in 10A circuit breaker.

Cat. MS-4024 **$59.95**

Audio Video Senders

2.4GHz AV Sender - Battery Operated

Wireless and compact, this is the ideal solution when power availability and space are a consideration. Both transmitter and receiver operate on battery power. Connection to the AV source is via 3.5mm to RCA composite video and audio lead (2 x 1m leads included).

Cat. AR-1852 **$79.95**

- Each unit requires 2 x AA batteries.
- Dimensions: 85(L) x 85(W) x 20(H)mm

Watch Pay TV All Over The House

Transmit clear video and sound from sources such as your set-top box, TV, DVD, pay TV, camcorders and security cameras to anywhere in your home, office or building. Avoid the congestion and interference on the crowded 2.4GHz band & enjoy reliability and assured picture quality with this 5.8GHz AV sender.

Cat. AR-1840 **$199.00**

- Range of up to 50m (line of sight)
- Built-in IR remote • No messy wires
- AR-1841 Additional receivers available separately

Kingray VHF/UHF Distribution Amplifier

Suitable for both analogue and digital free-to-air TV reception, this distribution amplifier is suitable for MATV applications. Housed in a stout, fully shielded diecast aluminium case, it features single or combined VHF/UHF inputs, separate VHF/UHF gain controls and -30dB test point. It's designed for indoor use, but may be used outdoors with the manufacturer's recommended weatherproof masthead housing. Mounting bracket and 12V plugpack included, or the unit may be line-powered via the coax cable. RF output is by F - type connectors

Cat. LT-3243 **$139.95**

- Frequency range: 44 - 230/520 - 860MHz
- Gain: 27dB - 32dB
- Noise: 5dB
- Return loss: 10dB
- Current consumption: 140mA
- Dimensions: 85(L) x 81(W) x 27(H)mm

UHF VHF TV Indoor Antenna

The ultimate indoor antenna - built-in mixer for UHF/VHF/FM - wide frequency band from 40MHz to 890MHz. Directional fine tuning possible with variable direction inner reflector - easy to mount - 75 ohm impedance with coaxial cable and plug.

Cat. LT-3130 **$17.95**

Video Enhancer and Stabiliser

Removes additional hidden signals from commercial videos and DVDs (such as copy protection) which can interfere with picture quality.

- Power supply and RCA cable included

Cat. AR-1822 **$129.95**

Fixed Attenuators

Fixed attenuators are a handy way to resolve ghosting and reflections caused by too high a signal strength created by RF or Video signals BNC, F-Type and RCA fixed attenuators will address this problem in the most reliable manner.

- Made from solid brass body with nickel plating
- Bandwidth: 5MHz to 1GHz
- All are inline (socket to plug) & DC blocking

	Atten.	Cat.	Price
RCA	3dB	LT-3051	$7.95
BNC	3dB	LT-3053	$7.95
BNC	6dB	LT-3055	$7.95
BNC	12dB	LT-3057	$7.95
F Type	3dB	LT-3052	$7.95
F Type	6dB	LT-3054	$7.95
F Type	12dB	LT-3056	$7.95
DC Blocking Module		LT-3070	$16.95

6 Input Audio Video Switcher

Watch one video source and record another simultaneously with this slimline selector. Supports component and composite video, S-video, digital audio. Remote control included. 280mm wide.

Cat. AC-1686 **$149.95**

USB DVD Maker

Turn your VHS tapes into exciting video productions or record live video straight to your DVD or CD burner. Editing software lets you add effects as well as sound tracks and titles to your work.

- Requires PC with suitable burner

Was $99.00 **SAVE $20**

Cat. XC-4809 **$79.00**

NEW Response Paper Cone Woofers

This new series of Response woofers are excellent for replacement or for new Hi-Fi speaker design constructions. Not only are they price competitive and perform very well, but they also look fantastic! The concave treated paper cone matched with rubber surround provides smooth overall response. Equipped with strong steel frame baskets, high power magnets & voice coils, these drivers will produce massive quantities of clean bass output for any musical application.

4" Shielded Paper Cone Woofer/Midrange
Nominal impedance: 8 ohms
Power nominal: 27WRMS
Frequency response: 70Hz - 7kHz

Cat. CW-2190 **$19.95**

6.5" Paper Cone Woofer/Midrange
Nominal impedance: 8 ohms
Power nominal: 60WRMS
Frequency response: 44Hz - 7kHz

Cat. CW-2194 **$29.95**

10" Paper Cone Woofer
Nominal impedance: 8 ohms
Power nominal: 225WRMS
Frequency response: 40Hz - 1kHz

Cat. CW-2198 **$39.95**

- CW-2192 5" 50WRMS $24.95
- CW-2196 8" 90WRMS $34.95
- CW-2199 12" 225WRMS $44.95

NEW Audio/Video Balun with Wall Plates

This excellent range of multimedia extenders transmit audio and video signals up to 300m over standard CAT5 UTP network cable and are available for both Component Video and Composite Video signals with and without audio. They are perfect for AV distribution systems in offices or home theatre applications etc. Several models are available and they are supplied in pairs.

Composite video & stereo audio LT-3036
Composite video, mono sound & DC power LT-3037
Component video LT-3038
Component video & digital audio LT-3039

Cat. LT-3036 **$69.95** Cat. LT-3037 **$69.95** Cat. LT-3038 **$69.95** Cat. LT-3039 **$79.95**

1:28 Scale Remote Control Ferrari Model Cars

These factory endorsed 1/28th scale Ferraris are outstanding. The full function remote control lets you move forward, backwards, left and right. The headlights illuminate as you accelerate and the taillights when you brake. They recharge from the display base and will look truly sexy on display in your office. With two frequencies and four models available you can, in the 'quiet' times, invite your colleagues in for some competitive racing.

FACTORY ENDORSED

- 8 yrs +
- Each model requires 4 x AA batteries (Use SB- 2425)

GT-3296 1:28 Ferrari F50GT 40MHz
GT-3297 1:28 Ferrari FXX 27MHz
GT-3298 1:28 Ferrari F40 Competizione 27MHz
GT-3299 1:28 Ferrari 575 GTC 40MHz

Each **$29.95**

Radio Controlled Mini Monster Truck

These little beasts have enormous wheels for getting over obstacles and working rear suspension for maximum traction. You can wheelstand them or just put the hammer down and run over things. The truck charges from the remote control to give about 10 minutes of rootin' tootin' redneck truckin' fun. Two models to choose from so you can race them against each other:

Green - 27MHz GT-3254
Red - 40MHz GT-3256

- Requires 4 x AA batteries (Use SB-2425)
- Measures: 98(L) x 65(H)mm
- Recommended for ages 8+

Each **$24.95**

Mains Outlet with RF Remote Control

Control your appliances with the push of a remote control button. This wireless control system can be used to remotely control an electrical appliance via the mains outlet. The remote unit is able to control a total of four outlets, so you can use it to control extra mains outlets or other slave devices. It has a range of about 50m and transmits at 433.92MHz.

- 1 x mains outlet & 1 x 4 channel RC supplied

Cat. MS-6130 **$39.95**

Additional Accessories Sold Separately

MS-6132	RF RC Mains Outlet	$24.95
MS-6134	RC for RF Devices	$24.95
MS-6136	Weatherproof RF RC Receiver 240V	$39.95
MS-6138	RF RC Receiver 240V	$29.95
MS-6139	RF RC Receiver 12V	$29.95

8 in 1 Universal RC with LCD Display

Can operate up to 8 different devices at once including TV, DVD players, VCR, RCVR, satellite TV, cable TV, stereos and air conditioning units. It comes pre-programmed for easy set up, quick search and works with over 100 brands of electrical devices.

SAVE $10

- Batteries included
- 210mm long

Was $34.95

Cat. AR-1725 **$24.95**

LED Wall Clock with RC

A wall-mounted clock that can easily be seen across the room, day or night. It comes with a remote controller to adjust the time after the clock has been wall mounted. It can be powered with the supplied plugpack or with 6 x AA batteries (use SB-2425).

Cat. AR-1785 **$49.95**

- 100mm LED digits
- Dimensions: 334(W) x 188(H) x 44(D)mm

RC Secret Farter

Just hide the box near your intended victim and activate it from a distance with your remote control button. Not only will they be embarrassed, they won't even know who is responsible.

- Requires 4 x AA batteries (Use SB-2425)

Cat. GH-1088 **$14.95**

RC Golf Ball

Fix your short game the best way possible - by cheating!

- Transmission range 10m
- Requires 2 x AA batteries (Use SB-2424)

Was $29.95

SAVE $5

Cat. GT-3265 **$24.95**

Mains Power Meter

The meter can tell you how much an appliance is costing to run and tracks the actual power being used. It can also display the instantaneous voltage or current being drawn as well as peak levels etc. 10A max rating.

Cat. MS-6115 **$39.95**

Multi Voltage Switchmode AC Adaptor

Features:

- Slide switch to select a range of different voltages
- Regulated output voltage
- High efficiency
- Lightweight
- Voltage VDC 3,4,5,6,9,12
- Approval N17789

Cat. MP-3130 **$21.95**

Large range of adaptors available - See our website for our full range

Power Point & Leakage Tester

Test your power points using this versatile tester. It checks most types of power points within 110V to 240V for correct wiring and earth leakage circuit breaker trip levels.

Cat. QP-2000 **$19.95**

YOUR LOCAL JAYCAR STORE

Australia Freecall Orders: Ph 1800 022 888

NEW SOUTH WALES

Albury	Ph (02) 6021 6788
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Blacktown	Ph (02) 9678 9669
Bondi Junction	Ph (02) 9369 3899
Brookvale	Ph (02) 9905 4130
Campbelltown	Ph (02) 4620 7151
Erina	Ph (02) 4365 3433
Gore Hill	Ph (02) 9439 4799
Hornsby	Ph (02) 9476 6221
Newcastle	Ph (02) 4965 3799
Parramatta	Ph (02) 9683 3377
Penrith	Ph (02) 4721 8337
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Silverwater	Ph (02) 9741 8557
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SERVICEMAN'S LOG

Who mangled Duck's USB ports?

Nothing comes even close to computers when ranking gear that's stuffed by consumers. As a result, I usually try to avoid fixing them but niece Duck's computer was different.

I have a niece who, at the tender age of three, was nicknamed "Duck". Well, Duck stuck and now at the even more tender age of 16, she's still lumbered with that stupid name.

Recently, Duck's computer failed and who better to fix it than this little black duck? The complaint was that the computer was dead. Not even the power supply was starting up.

When the box arrived, I hooked it up and pressed the power switch. Nothing happened – it was as dead as a dodo.

This was going to be easy. After all, as everyone knows, if you press the power switch and nothing happens, it's just got to be the power supply. Yeah, right!

When I removed the side panel, I immediately spotted two obviously faulty electrolytic capacitors between the processor and the memory sockets. Both had bulging tops which were covered in a brown crust due to leaking electrolyte. Then I spotted two more identical capacitors with bulging tops and leaking electrolyte in another section of the motherboard.

So it was beginning to appear that it was a motherboard fault that was preventing the power supply from starting up. That's because, on an ATX machine, the power switch is connected to two pins on the motherboard and it's the motherboard that then starts the power supply (via the main connector) when the power switch is pressed.

The question was, was it just the capacitors that were faulty or had something else on the motherboard failed as well? There was only one way to find out and that was to replace them. If it worked, it worked. If it didn't, then the motherboard would be a "bin job".

I removed the motherboard and took a closer look at the leaking capacitors. They were all 3300µF 6.3V types branded "GSC". A quick Google of "GSC 3300µF" showed that these blighters have caused problems on lots of other motherboards over the years, not just on this 6-year-old Gigabyte GA-7VKML.

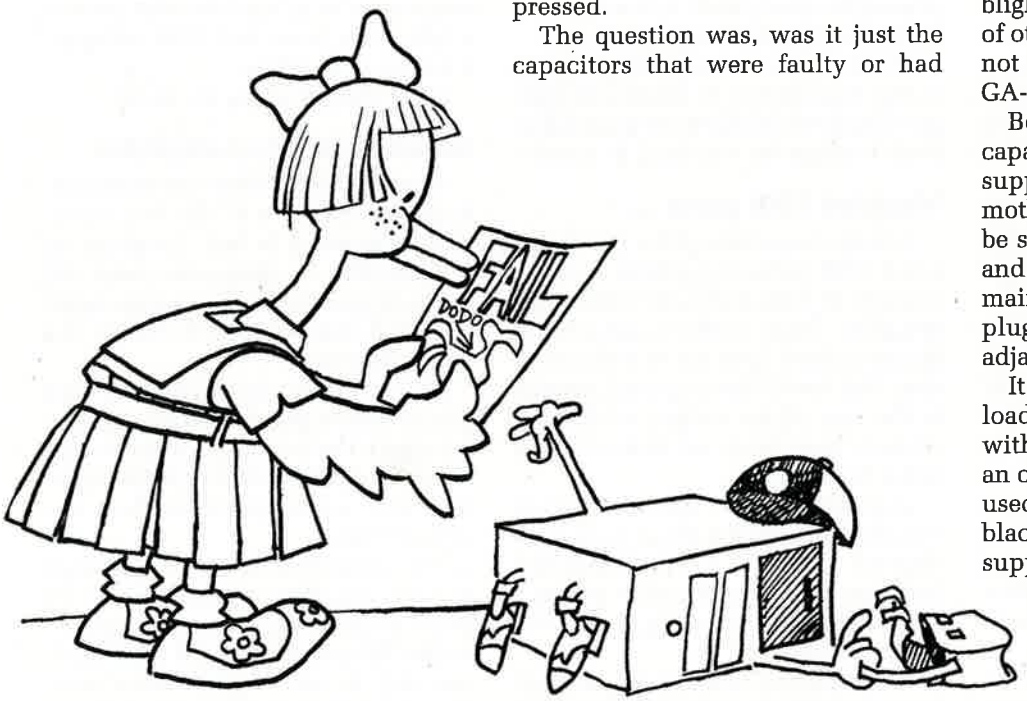
Before replacing the motherboard capacitors, I decided to test the power supply. When not hooked up to a motherboard, most ATX supplies can be started simply by applying power and shorting the green wire on the main connector plug (ie, the one that plugs into the motherboard) to an adjacent black wire (ground).

It's also a good idea to connect a load, as some supplies won't start without one. In this case, I connected an old floppy drive to the supply and used a paper clip to short the green and black wires on the plug. The power supply fan immediately burst into life and I was able to confirm that the +5V and +12V rails were present on the disk drive connectors.

Having cleared the power supply, I went back to the motherboard. Removing capacitors from

Items Covered This Month

- Gigabyte GA-7VKML motherboard
- Ace Radio audio amplifier
- Sony KV-DA32M36 CRT TV set
- Yamaha RX-V596 Prologic receiver
- Philips 32FL2881/75R TV set (FL2G chassis)



RECENTLY, DUCK'S COMPUTER FAILED...

USING A HOT IRON WITH A FINE-POINTED TIP, I "WRIGGLED EACH CAPACITOR OUT OF ITS MOUNTING HOLES

a multilayer board is never easy, as care has to be taken not to damage the tiny pads or any adjacent tracks. However, by using a hot iron with a fine-pointed tip, I was eventually able to "wriggle" each capacitor out of its mounting holes. I then used a needle which I heated with the soldering iron to clear the holes of solder before installing four new 3300µF 10V (105°) low-ESR capacitors into the vacant positions.

That done, I sat the motherboard on a cardboard box, plugged in the power supply and briefly shorted the motherboard's power switch pins. The power supply immediately started, so it looked like the problem was solved. All that remained now was to re-install the motherboard in the case, plug in all the cables and batten down the hatches – or so I thought.

Well I did that but when I attempted to restart the computer for a final test, it was as dead as a dodo again. What was going on? I'd fixed the faulty capacitors but there was obviously another fault lurking in the works somewhere.

I decided to see if I could make the problem go away by disconnecting each item in turn. It didn't take long to nail the culprit. Disconnecting the supply connectors to the disk drives made no difference but when I disconnected the front-panel USB connector cable from the motherboard and pressed the power switch, the machine immediately switched on!

In fact, after reconnecting power to the disk drives, it booted straight into Windows and behaved normally. Duck's computer was back in action!

Mangled USB ports

A close inspection of the two front-panel USB sockets revealed that the contacts in both had been thoroughly mangled. These contacts usually lie flat on a plastic base but in both cases, they had been lifted up and pushed to the rear of the socket, so that all contacts were bent and shorted to the metal housing.

That also meant that the power supply contacts in both sockets were shorted to earth. The motherboard had been detecting this short and as a result, had been refusing to start the power supply.

In the end, the cure was simple – just leave the USB cable disconnected and seal the two faulty front-panel USB connectors. Replacing them wasn't an option, as they are moulded into a fitting which also includes the front-panel audio output and microphone sockets.

It's not uncommon

Apparently, damage to USB sockets is not uncommon. In fact, when I mentioned it to a colleague, he immediately showed me a notebook computer with a damaged USB socket that had all its metal contacts sitting in mid-air (see photo). Another colleague had also encountered several computers with similar damage to USB sockets

It's probably due to the plug being forced upwards (or downwards) as some heavy-handed person "yanks" it out of the socket. When that happens, the plug acts as a lever and bends the plastic base inside the socket as it is removed. The base subsequently springs back into place but the metal contact strips don't and are left stranded in mid-air.

The next time someone attempts to plug in a USB cable, it won't fit because the ends of these metal contacts now butt against the plastic base inside the plug. Any attempt to force the plug in only mangles the contacts further.

In Duck's machine, someone must have applied considerable force to the USB connector because the contacts had all been bent to the rear of both sockets. Apparently, there are strong suspicions as to just who this person might have been but DNA samples have yet to be taken.

Duck should wring his neck!

An ancient valve amplifier

Many people out there are beginning to realise that a lot of old (and not so old) technology is fast disappearing into landfill. In particular, most old valve equipment has long gone, apart from that remaining in the hands of a few enthusiasts.

Occasionally, however, the odd piece of valve gear does come my way for repair. For example, I was recently asked to repair an old Ace Radio (Marrickville) audio amplifier from the early 1960s.

This particular unit had been used as a PA amplifier at Manly Wharf for many years. It had then been donated to Dee Why Surf Club and used until, one day, it and its accessories were swamped by a small tsunami. It was then sold off cheaply, a little worse for

wear but still working (just).

The new owner really only wanted to use it for spare parts and removed the output transformer to use in another amplifier. But then, some years later, he decided to reinstall the transformer back into the original Ace Radio unit to get it working again.

When he did, the output was lower than normal and he noticed that if he removed one of the output valves (V4) EL84/6BQ5), the sound actually got louder. However, if he removed the other output valve (V3) instead, there was no sound!

Not sure of the condition of the valves, he swapped them around with the other amplifier. Most made no difference but swapping the ECC83/12AX7 (V2) caused the amplifier to go into an uncontrollable howl. And that's when he brought it in to me.

Not having a circuit diagram but being of Pommie descent, I recognised the design to be based loosely on the Mullard 5-10. And fortunately, I still had my bible "Mullard Circuits for Audio Amplifiers", 2nd Edition August 1960 which I acquired when I built my Stern-Clyne kit from London (along with many others).

The Ace Radio version still had wax capacitors and old style resistors where the body colour was the first digit. I began by measuring the voltages on the outputs and soon discovered that one of them was switched off at the phase splitter. The EF86/6BK8 was also nearly switched off too.

Anyway, bearing in mind its 40-year old status, it was hard to know where to start. I began with the old capacitors, changing them for the later Philips beige axial polyesters and rounding the .05µF units to .047µF. The electrolytics were also replaced, with the 25µF and 16µF units replaced by 22µF capacitors.

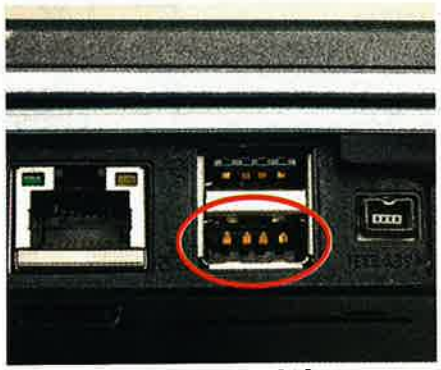
Some of the resistors in this old corroded amplifier were very much the worse for wear. These included the 325Ω wirewound cathode resistors on the output valves. I replaced these with 330Ω units and out of interest, checked the old resistors on my DMM. They were a long way from the marked values.

The old Ace Radio amplifier had been modified and repaired several times during its long life, so I couldn't be certain as to its exact original configuration. Unfortunately, after replacing most of the remaining resistors and capacitors with new high-stability types, the symptoms were still the same. I also noticed that the two output cathodes had been strapped together with no parallel electros – not that this made any difference to the symptoms.

I was beginning to suspect the Ferguson output transformer, so I tried swapping the leads around from one valve to another but it made no difference. I then disconnected the negative feedback from the output stage and that too made no difference.

I did notice, however, that if V1 (EF86/6BK8) was removed, all the voltages in the rest of the amplifier returned to normal. As a result, I spent a lot of time checking its operating conditions. I even went to the extent of replacing the old rusty valve sockets in case the sea water had made them conductive but as usual, it was a case of a lot of different symptoms and not knowing which ones were significant.

These are the four 3300µF electrolytic capacitors removed from the Gigabyte GA-7VKML motherboard (all carried a "GSC" brand). Note the bulging tops and the leaking electrolyte.



This view shows a mangled USB port (circled) on a colleague's notebook computer. Note how the pins are all sitting in mid-air.

In fact it was the ECC83/12AX7 valve (V2) that gave the important clue. Assuming its replacement was

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OK, why did it go into an uncontrollable howl?

This oscillation had to be caused by feedback, so I shorted out the (obviously) positive feedback to ground from the output transformer and the howling stopped instantly. I then rewired the output leads so that it correctly gave negative feedback instead of positive feedback and that fixed the problem completely.

The original valve (V2) was faulty or low emission. How someone had managed to wire the leads the wrong way round was a bit of a mystery as their lengths made it impossible to do it any other way without extending them.

This successful repair has meant that I am now required to repair more ancient valve equipment from the same owner, starting with a 2-valve AM tuner. If only there was decent money in it!

A sick Sony

We sold a Sony KV-DA32M36 CRT TV to a client back in 2005. It performed flawlessly up until a few weeks ago, when the owner called complaining of a poor picture.

When I got there, I found that the picture was washed out. It was as though there was no luminance, and yet the OSD menus were all OK and the PIP (Picture-in-Picture) was also good. However, you could not swap the picture quality over between the main picture and the PIP.

There were no error codes and all the B+ levels looked OK, so there was nothing for it but to take this extremely heavy set to the workshop and dust the cobwebs off the CRO.

I was mainly interested in finding out where the main luminance was disappearing. Tracing the signal path was extremely difficult but I managed to follow it through onto digital signal board BH1 from the AVSW, comb filter and A boards. From there, it goes via a low-pass filter to a Helios microprocessor (IC3301, CXD3808AQ).

I soon realised I was out of my depth and figured that this 240-pin surface mounted IC was not for me to tackle. Instead, I ordered an expensive BH1 replacement board (Part No. A-1084-427-A) and crossed my fingers that I had done the right thing.

You can imagine my relief when I plugged the new one in and was rewarded with an excellent picture on all channels.

The freebie LCD TV

Recently, a colleague gave me a small Toshiba LCD TV (14JL7A) that he had given up repairing, with the intent that I use it for spare parts. It came without its 19V power supply and I was told that there was no picture and only intermittent sound.

Ever the optimist, I thought that I would give it a go before I started robbing it for parts, using a regulated bench power supply which at a stretch I could crank up to 18V. You can imagine my surprise when I got not only full sound but an excellent picture as well. Obviously, I thought, the fault must be intermittent so I left it on to soak test but the hours stretched into days with no sign of any fault.

The next time I saw my friend the conversation drifted onto this TV. He was dumbfounded when I told him that it was working perfectly and that I hadn't done anything to fix it. I then hassled him for the original power supply (what are friends for?) which he eventually found and I took it back to my workshop.

When I plugged it in, I measured the output on the DC plug to be spot on. However, when I connected it to the Toshiba LCD TV, I saw for the first time the symptoms my friend had described. I could also see why it had "fooled" him. If I had not originally connected my own power supply, I would have also said that the fault was in the TV itself.

Anyway, I noticed that if you listened carefully to the fully enclosed power supply, you could hear a rustling noise as though a cockroach had got inside! As a result, I prised open the glued plastic case and took a look at the PC board.

I quickly noticed that the solder joint on D2 had been getting quite hot and when I measured the FR107 diode, it was short circuit. I had the usual "kerfuffle" of trying to source a replacement and eventually settled for a UF4007. I also replaced C11, a 47µF 25V electro which fed the FET.

At switch on, I was delighted to see that the TV now came on perfectly with this supply. What's more, the cockroach had taken his rustle away!

Having fixed it, I decided to keep this little set as it's really quite nice – and it needs soak testing! It's just a shame that I didn't get the stand that goes with it.

Yamaha Prologic receiver

A Yamaha RX-V596 AV Prologic receiver was left at reception DOA (dead on arrival), the customer requesting a cheap Lazarus job.

My only comment to that request was that you can have one or the other but not both. Anyway, the money eventually talked loud enough for me to get stuck into it.

Apparently, following a thunderstorm, the receiver would no longer switch on. In fact, there were no lights and no display – it would just click and then turn off.

This is a complex unit with an equally complex "Diagnostic Mode" which, when selected, tricks the microprocessor and bypasses the protection circuits. To start this diagnostic program, you have to hold down the righthand "Preset /Tuning" and "A/B/C/D/E" keys while simultaneously pressing the "Standby/On" button. Submenu 1 will then start.

Unfortunately, none of this was working, so I checked out all the power

lines only to find that they were all spot on. As a result, my next move was to order and change the microprocessor. It wasn't all that expensive but unfortunately it made no difference.

I also kept pressing the three "Diagnostic Mode" buttons in the hope that something might happen and believe it or not, my prayers finally worked when for a very brief moment the Display dimly showed "PRV". This was the clue I so desperately needed, but first a buzz word glossary: (1) "PRI" means Over Current Protection; (2) "PRV" means Power Voltage Protection; and (3) "PRD" means Power Amplifier Voltage.

The one I was now interested in therefore was the voltage protection line to pin 91 of microcontroller IC501. This involves a network of seven or eight resistors from the power supply rails, which together bias pin 91 to 1.5V. If any of the supply rails or resistors fail, then the 1.5V would change and the set would turn off, which was precisely what was happening.

In fact, a quick check showed that pin 91 was at just 0.8V. To confirm my hypothesis, I connected a 10kΩ resistor (as a random example) to the +5V rail and it was enough to raise the voltage to 1.5V and enable the microcontroller. In addition, the Diagnostics mode could now be fully accessed and it confirmed all the above.

So what had caused this? Well, it was really simple from now on. All I had to do was measure all the resistors from the supply rails to pin 91 (the PRV1 line) of the microcontroller. Well, of course, it does sound simple except that physical access is a problem and that meant major surgery to get at those resistors.

Eventually, after a lot of hard yakka, I found the @#$%^&. It was R230 (47kΩ) which runs from the +25V rail on the PRV2 line and plugs into the PRV1 line via CB104 on the PCB Input 1 Board.

Now that the unit was working, I found a secondary problem. The DVD kept defaulting to "Disco Sound Mode" and there was no ProLogic decoding. This fault had previously been masked by the first problem but when I quizzed the client, he was fortunately only too well aware that it had been an existing problem. A new board would cost in excess of $460 but he wasn't prepared to go that far and was happy enough to use the unit without the ProLogic sound.

A beautiful Philips

Some of the expensive and beautiful sets imported by NAPF Electronics directly from Philips in Europe are now coming in for repair even though they are a bit long in the tooth at around 15 years old. One such set was a Philips 32FL2881/75R employing an FL2G chassis. It would come on with a beautiful picture and sound for around two minutes and then cut off.

The diagnostics available on this set are read out via seven LEDs on Computer Board W on the SSP (small signal panel) inside the set. Four of these LEDs are also in parallel with the LEDs on the front panel.

When the fault was present, two of these LEDs would flash. The big problem for me was trying to work out whether these LEDs were numbers 1 and 2 (ie, LEDs 6053 & 6051) or 6 and 7, as the manual is very confusing. However, after studying the manual, I eventually interpreted the LED readouts as indicating a 03 error code message. That in turn indicated a problem in the Proscan Box "H, H1".

The Proscan box takes care of a number of functions, including (as far as I can determine) Teletext, PIP and the aspect ratio. However, being rather cynical about the reliability of diagnostic systems, I decided to do some basic tests myself.

First, I momentarily shorted a cathode of the CRT to ground via a 10kΩ resistor and found that there was no vertical deflection. Then, despite the difficult access, I measured the B+ rails feeding the vertical output timebase on the G Board.

These were all OK so I checked for dry joints, first by tapping the board and then by heating and cooling the board. However, there seemed to be nothing wrong with the output stages on the G Board.

I had put off checking the Proscan Module as it was the most inaccessible board in the set. It has a lot of metalwork screening, all held in place by concealed clips. However, I eventually managed to remove this board from the set and then tried running the set without it. The sound was now much better and there was a full raster, albeit with a little vertical foldover in the centre.

By now, I really felt that I was getting somewhere, so I reconnected the Proscan module (H Board) and applied all the tests I had just done to the G Board. It made almost no difference until I hit it with a lot of freezer, whereupon the picture momentarily returned.

I took the board out and carefully examined what appeared to be the heat sensitive area but initially could find nothing wrong. However, while resoldering some possible dry joints, I suddenly detected a fish-like smell and instantly knew that I had electrolytic capacitor problems.

In the end, I changed a number of "fishy" electros, including C2046 (10µF), C2064 (100µF) and C2081 (47µF). However, my money was really on C2092, a 47µF electro in the "Watchdog" circuit.

Replacing all four and cleaning the board restored the picture completely. Shorting the Service Mode Test Points S26 and S27 on the SSP then brought up all the error codes since the set was last used, in this case 08, 03, 04, 26 & 99.

After I switched the set to Standby and tried again, I was rewarded with five zeros, meaning that there were no more errors. SC

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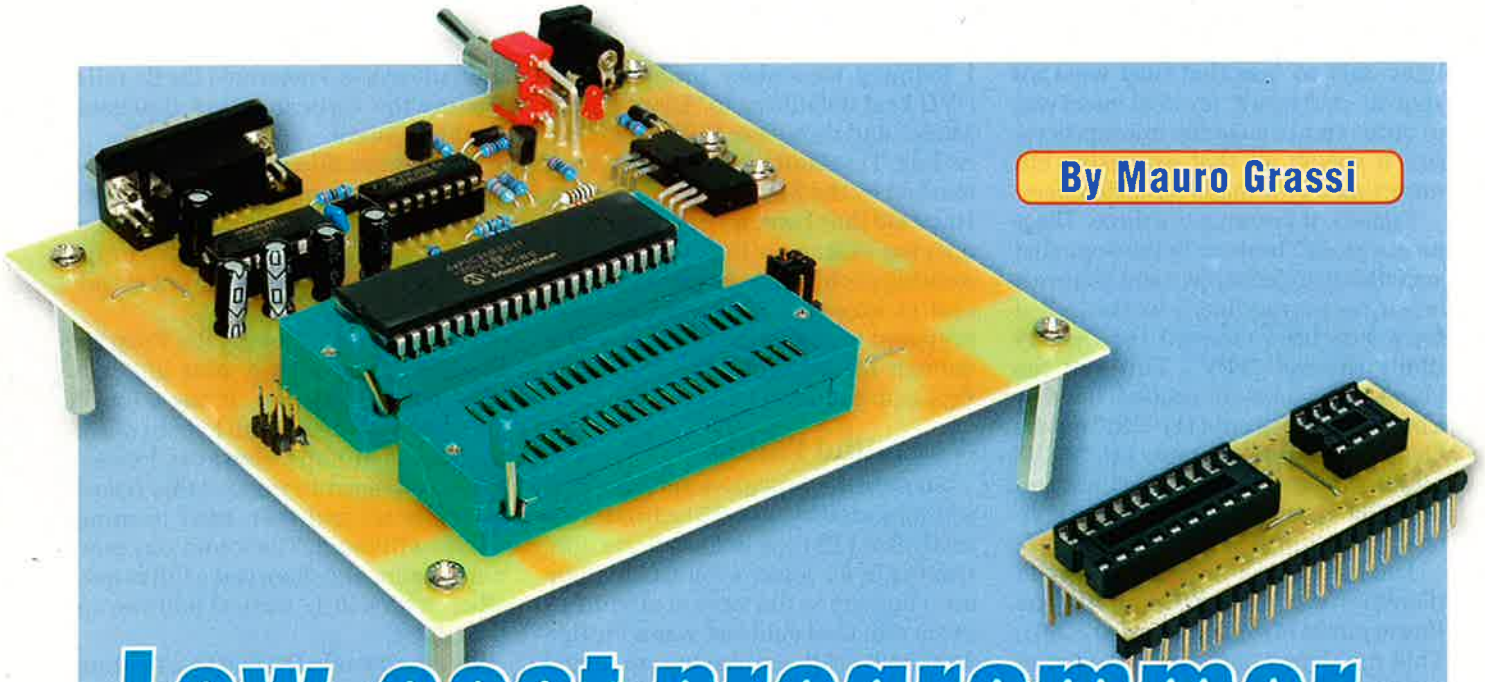

By Mauro Grassi

Low-cost programmer for dsPICs & PICs

This low-cost unit can program all dsPIC30F series microcontrollers in the DIP package, along with most PIC microcontrollers. It's easy to build and uses standard parts.

PICs ARE NOW ONE of the most widely used microcontrollers. Like all micros, they greatly simplify many electronic designs, are reconfigurable in the field and allow projects that would be unwieldy or overly complex without them. In addition, extra features can often be added retrospectively to the firmware.

Although the PIC family of microcontrollers is well known (we have published many projects that employ PICs), Microchip also manufactures the lesser-known dsPIC30F series of microcontrollers.

These are microcontrollers with similar peripherals to those found on standard PICs but which have an enhanced instruction set augmented with DSP (digital signal processing) type operations. They are 16-bit microcontrollers and are surprisingly powerful, running at speeds in the tens of MIPs (millions of instructions per second).

Dedicated single-cycle DSP operations like MAC (multiply and accumulate) allow them to perform real-time signal processing using multiple 40-bit accumulators. They also incorporate hardware multiplication and division and have surprisingly fast ADC acquisition modes. These features make them well-suited to many digital signal processing applications.

One such device, the dsPIC30F4011, will feature in a new digital Musicolour lightshow project to be published soon in SILICON CHIP. This particular device can perform a real-time FFT (Fast Fourier Transform) on audio-band signals with ADC acquisition modes that can operate at up to 1MS/s (1 million samples per second). It runs at close to 30MIPs and has 48kB of program memory.

Programming them

The dsPIC30F series of microcontrollers are extremely useful but most older PIC programmers cannot program them. This is due to incompatibilities with the pin-outs of the dsPIC family.

As a result, we have designed this simple, low-cost dsPIC and PIC programmer. It can program all the dsPIC30F family of microcontrollers that are available in a DIP package, as well as almost all regular PICs. It uses freely-available software (for the PC) and is easy to build.

By the way, if you have ever wanted to experiment with DSPs (digital signal processors), the dsPIC30F series is a good starting point. Microchip offers a lot of documentation and source code for free on their website **www.microchip.com**.

Programming procedure

Our new programmer is based on the original COM84 style programmer – so named because it was designed to program 16F84 microprocessors from

a serial port. There are really three lines which are necessary to program most PICs and microcontrollers in the dsPIC30F family: CLOCK (PGC), DATA (PGD) and V_{PP} (programming voltage).

Incidentally, the dsPIC30F family has two programming modes – enhanced and standard. The enhanced mode is faster and requires a programming executive or "bootloader" to be programmed in first. However, this programmer uses only the slower ICSP mode that is standard across the PIC family (ICSP = In-Circuit Serial Programming).

If you are interested in the details of the ICSP protocol, refer to the Microchip website at **www.microchip.com** (look for the "memory programming specifications").

Programming mode is entered by raising V_{PP} up to around 13V. Data is then programmed into the microcontroller by serially shifting commands and data using the PGC and PGD lines.

The PGC line synchronises the exchange of serial bits, while the PGD line contains the data. The PGD line is bidirectional, allowing reading and writing of the microcontroller.

For example, there is a command code for "Erase" which will erase the flash memory of the microcontroller. There are also commands for "Writing" and "Reading" pages, etc. As soon as the microcontroller enters programming mode, it starts listening for commands.

Circuit details

To successfully program a PIC or dsPIC series microcontroller, we must be able to control the PGC, PGD and VPP lines in the correct fashion. The SILICON CHIP dsPIC/PIC Programmer achieves this by giving control of these lines to the software running on a PC. This software program is called "WinPIC" and it makes sure that the correct procedure is followed for a particular device.

Fig.1 shows the circuit details. As can be seen, the dsPIC/PIC Programmer has two distinct supply rails (+5V & +13.6V) and these are derived from the DC supply rail using two 3-terminal regulators (REG1 & REG2). S1 is the power on/off switch, LED1 provides power indication and diode D1 provides reverse polarity protection.

REG2 is an LM317T variable voltage regulator. Its output is determined by the bias applied to its ADJ terminal, as determined by the voltage divider formed by the 120Ω resistor and the series 1.1kΩ & 82Ω resistors.

If R1 is the resistance between the OUT and ADJ terminals (120Ω in our case) and R2 is the resistance between ADJ and GND (1182Ω), then the LM317T will regulate its output voltage to: $V = 1.25 \times (1 + R2/R1)$. Note, however, that slight manufacturing variations mean that the 1.25 factor can be anywhere between 1.2 and 1.3 in actual practice.

In this case, R1 & R2 have been selected so that REG2 regulates its output to 13.6V in typical conditions. This provides the MCLR-bar/Vpp voltage for the microcontroller which should

Main Features & Devices Supported

Features

(1) Will program all dsPIC30F series microcontrollers in the DIP package
(2) Will program most PICs in DIP package
(3) Uses PC freeware WinPIC for Windows
(4) Connects to the serial (RS232) port of a PC
(5) Very low cost

Minimum Supported Devices (others may also work)

10F series
10F200/202/204/206 (E) (*)

12F series
12F508/509 (E)
12F609/615 (E)
12F629/675 (E) (*)
12F635/636/639 (E)
12F683 (E)

16F series
16F610/616 (E)
16F627/627A/628/628A (*)
16F630/631/636/639/676/677/684/685/687/688/689 (E)
16F648/648A
16F716
16F73/737/74/76/77
16F818/819
16F84/84A/87/88 (*)
16F870/871/872
16F873/873A/874/874A/876/876A/877/877A (*)
16F913/914/916/917

18F series
18F2220/2320/4220/4320
18F2331/2431/4331/4431
18F2420/2520/4420/4520
18F2450/4450
18F2455/2550/4455/4550 (*)
18F2480/2580/4480/4580
18F2525/26204525/4620
18F2439/2539/4439/4539
18F242/252/442/452/
18F2585/4585/2680/4680
18F248/258/448/458
18F2682/2685/4682/4685

dsPIC30F series
dsPIC30F2010 (*)
dsPIC30F2011/3012 (*)
dsPIC30F2012/3013 (*)
dsPIC30F3010 (*)
dsPIC30F3011 (*)
dsPIC30F3014/4013 (*)
dsPIC30F4011 (*)
dsPIC30F4012 (*)

(*) = tested & passed. (E) = requires external connection or adaptor socket.

Parts List

1 PC board, code 07105081, 122 x 120mm
1 adaptor PC board, code 07105083, 52 x 19mm
1 16V 400mA DC plugpack
1 SPDT right-angle PC-mount toggle switch (S1)
1 PC-mount 2.5mm DC socket (CON1)
1 DB9 female right-angle socket (CON2)
1 DIP14 IC socket
1 DIP16 IC socket
2 DIP40 ZIF sockets
2 jumper shunts
1 8-pin DIL header with 2.54mm spacing
1 6-pin DIL header with 2.54mm spacing
1 500mm length of 0.7mm tinned copper wire
4 M3 x 6mm screws
2 M3 nuts
2 M3 x 10mm screws
4 9mm long M3 tapped spacers

Semiconductors

1 MAX232A RS232 line driver receiver (IC1)
1 74LS04 hex inverter (IC2)
1 BC337 NPN transistor (Q1)
1 BC327 PNP transistor (Q2)
1 7805 5V regulator (REG1)
1 LM317T regulator (REG2)
3 1N4004 diodes (D1-D3)
1 red 3mm LED (LED1)

Capacitors

1 10µF 16V electrolytic
7 1µF 16V electrolytic
2 100nF monolithic (code 100n or 104)
2 22pF ceramic

Resistors (0.25W, 1%)

6 2.2kΩ
1 1.1kΩ
1 120Ω
1 82Ω
3 39Ω

ideally be between 12.8V and 13.1V. However, anything from 13.4V to 13.8V is actually OK at REG2's output, since this is fed through transistor switch Q2 and series diode D2 before being applied to the MCLR-bar/V_{PP} (master clear/programming voltage) pin of the microcontroller to be programmed.

In operation, the regulated 13.6V rail from REG2 is switched on and off by PNP transistor Q2 which in turn is switched on and off by NPN transistor Q1. When pin 3 (Tx) of the serial port is high, it will switch Q1 on, in turn switching Q2 on and applying around 13V to the MCLR-bar/V_{PP} pin on the microcontroller to be programmed.

Conversely, when pin 3 of the serial port is low, Q1 will be off and therefore Q2 will also be off. In this case, the 2.2kΩ resistor on D2's cathode will pull the MCLR-bar/V_{PP} pin low.

Basically, on a PIC or dsPIC microcontroller, the MCLR-bar/V_{PP} pin acts either as a Reset (0V) or a programming voltage pin (around 13V for PICs or between 9V and 13V for a dsPIC30F series microcontroller). When MCLR-bar/V_{PP} is low, the microcontroller is in the Reset state (meaning that all its configurable pins are high impedance inputs). When it is high (around V_{DD} = +5V), the microcontroller runs in program mode and if it is at Vpp the microcontroller will enter programming mode.

It was a deliberate design decision to switch the MCLR-bar/V_{PP} line between 0V and V_{PP} rather than between V_{DD} and V_{PP}. This was done to avoid possible damage to the microcontroller being programmed.

To explain, if the MCLR-bar/V_{PP} line were switched between V_{DD} and V_{PP}, the program would run on the microcontroller when programming finishes. If that program were to drive the output pins (as digital outputs or as peripheral outputs), it could cause excessive currents to flow and damage the output stages of those pins.

That's because the ZIF sockets have many power connections to accommodate different PICs and dsPICs (+5V and GND). As a result, some of the microcontroller's output pins could be shorted to +5V or to ground if the program were to run.

For this reason, the V_{PP} pin is switched from 0V to 13V so that the microcontroller is never in the running mode.

Of course, if you were to incorporate this programmer onto a PC board that catered for ICSP (in-circuit-serial-programming) then you would have this line switch from V_{DD} (+5V) to 13V and the reset would occur on any transition from 13V down to 5V. Refer to the section entitled "External Programming Using CON3") for more details.

Note that some PIC microcontrollers can be configured to disable the Reset function of the MCLR-bar/V_{PP} pin, allowing it to be used for an alternative (multiplexed) function. This should be avoided when using this programmer with a dsPIC or PIC plugged into a ZIF socket, for the reasons outlined above (this does not apply when using CON3 to program an external device).

Regulator REG1 is used to derive the +5V rail and this is used to power IC1, IC2 and the microcontroller being programmed. This +5V rail is bypassed using 10µF, 1µF and 100nF capacitors, while a 1µF capacitor also bypasses REG1's input.

Control lines

The relevant lines used in the RS-232 serial interface to control the dsPIC/PIC Programmer are derived from pins 3, 4, 5, 7 & 8.

Pin 5 is the ground connection while pins 3, 4 & 7 (respectively Tx, DTR and RTS) are outputs from the serial port. In particular, pins 4 & 7 are digital outputs, while pin 3 is usually the Transmit line of the serial port. These are controlled by the WinPIC software on the PC as appropriate.

Finally, pin 8 (CTS) is an input pin and this is used to read data from the microcontroller, as required to verify or read the state of the memory.

IC1 is a MAX232 RS-232 line driver receiver. Its job is to translate between the RS-232 voltage levels (ie, ±10V) at the serial port and the TTL levels (0-5V) used by the microcontroller. As mentioned, pins 4 & 7 of the serial port are standard digital outputs and these are connected directly to IC1.

In operation, the MAX232 actually inverts the levels and so its outputs at pins 9 & 12 are fed to inverter IC2a & IC2f (part of a 74LS04 hex inverter) to invert them back again.

Pin 7 of the serial port controls the PGC (CLOCK) line and is applied to the microcontroller via IC1, IC2a and a 39Ω resistor (to limit the current). In addition, a 22pF ceramic capacitor is used to filter any high-frequency noise on this line.

Pin 4 controls the PGD line (DATA) output. When it goes low, so does the pin 12 output of inverter IC2f. Diode D3 allows a low level from IC2f to drive the PGD line but blocks high-level signals from IC2f. A 2.2kΩ pull-up resistor is used instead to pull this line high. This allows the WinPIC software to read the PGD line from the microcontroller via pin 8 of the serial

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port (ie, after sending pin 4 of the serial port high).

So the PGD line is actually "bi-directional" and is used as an output when writing to the microcontroller and as an input when reading from the microcontroller.

Note that, as with the PGC line, the PGD line is fed via a 39Ω resistor and is filtered using a 22pF ceramic capacitor to reduce spurious noise.

Two ZIF (zero insertion force) sockets are used to accept the microcontroller to be programmed. ZIF SKT1 is used for dsPIC30F series microcontrollers and they should always be aligned with their pin 1 going to pin 1 of the ZIF socket.

Alternatively, ZIF SKT2 should be used for programming standard PICs like the 16F88. As before, pin 1 of the microcontroller goes to pin 1 of the ZIF socket.

Note, however, that the 10F and 12F series of PICs are not compatible with the onboard ZIF socket. These must be programmed via an external adaptor board, as described later, or by using CON3 and a breadboard.

External programming

CON3 is a 6-pin header and its pinout is arranged as shown in Table 1. It can be used to access the five relevant lines required to program both PICs and dsPICs externally (see the section entitled "External Programming Using CON3" below).

For example, if your PIC is not actually compatible with the pinning of ZIF SKT2 (eg, if you have a PIC10F202), then you may use this connector to access the relevant lines. These lines can be connected to, say, a breadboard, to program your PIC off the PC board. Of course, you can also use this connector to program microcontrollers in circuit as well.

Jumper settings

Finally, there is an 8-pin header which accepts jumper shunts JP1-JP4. **However, only two of the four positions should ever be shorted at any one time.** Table 2 shows the jumper functions.

In practice, you must set these according to the microcontroller being programmed. Either JP1 or JP2 (but not both) must be shorted according to the type of dsPIC being programmed in ZIF SKT1, while JP3 or JP4 (but not both) must be shorted according

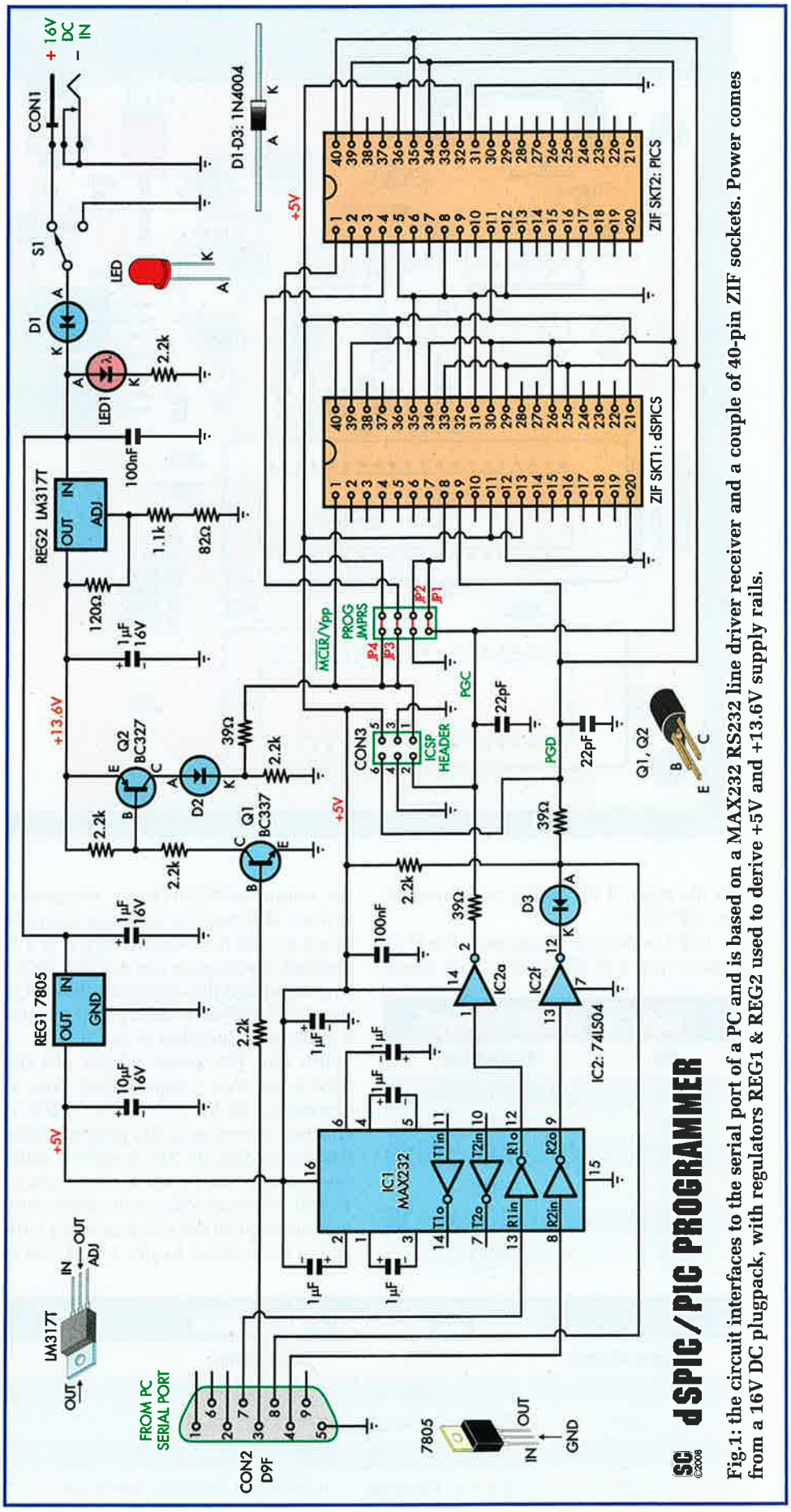


Fig.1: the circuit interfaces to the serial port of a PC and is based on a MAX232 RS232 line driver receiver and a couple of 40-pin ZIF sockets. Power comes from a 16V DC plugpack, with regulators REG1 & REG2 used to derive +5V and +13.6V supply rails.

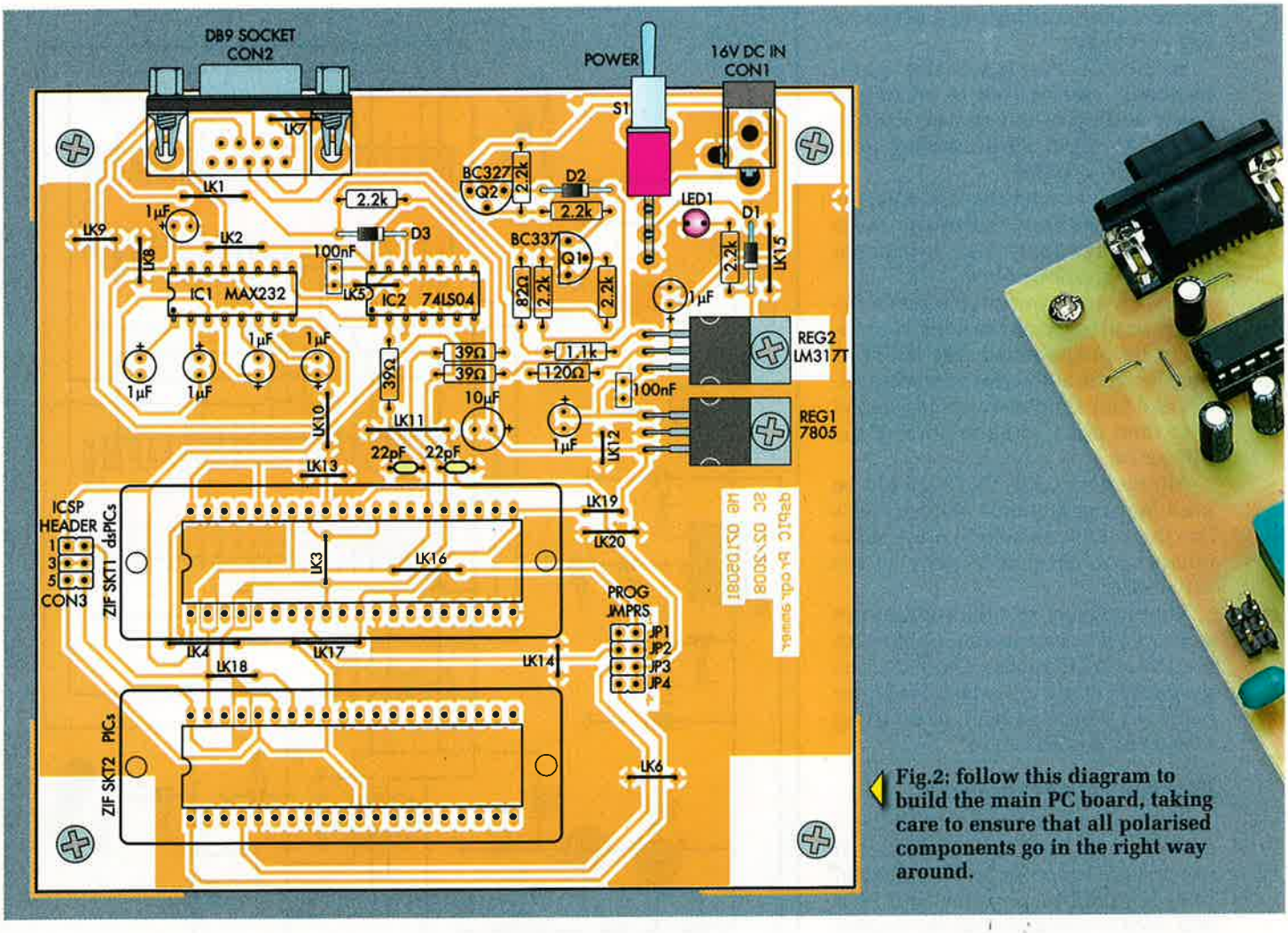


Fig.2: follow this diagram to build the main PC board, taking care to ensure that all polarised components go in the right way around.

to the type of PIC being programmed in ZIF SKT2.

If JP1 is shorted, it connects the PGC line to pin 8 of ZIF SKT1. This caters for some dsPIC30Fxxxx microcontrollers that require the programming clock on pin 8. Alternatively, if JP2 is shorted, it connects pin 8 of ZIF SKT1 to ground and this caters for the rest of the dsPIC30Fxxxx family that require a ground connection at pin 8.

JP3 and JP4 select which pin the MCLR-bar/V_{PP} programming line is connected to on ZIF SKT2. If JP3 is shorted, it connects the programming line to pin 4 of ZIF SKT2 and this suits microcontrollers such as the popular 16F88. Alternatively, some microcontrollers require the programming voltage to be applied to pin 1 and this is selected by installing JP4 instead.

Table 1: CON3 Pinout

Pin	Description
1	MCLR-bar/V_{PP}
2	PGC
3	GND
4	GND
5	+5V rail (V_{DD})
6	PGD

Table 2: Jumper Functions

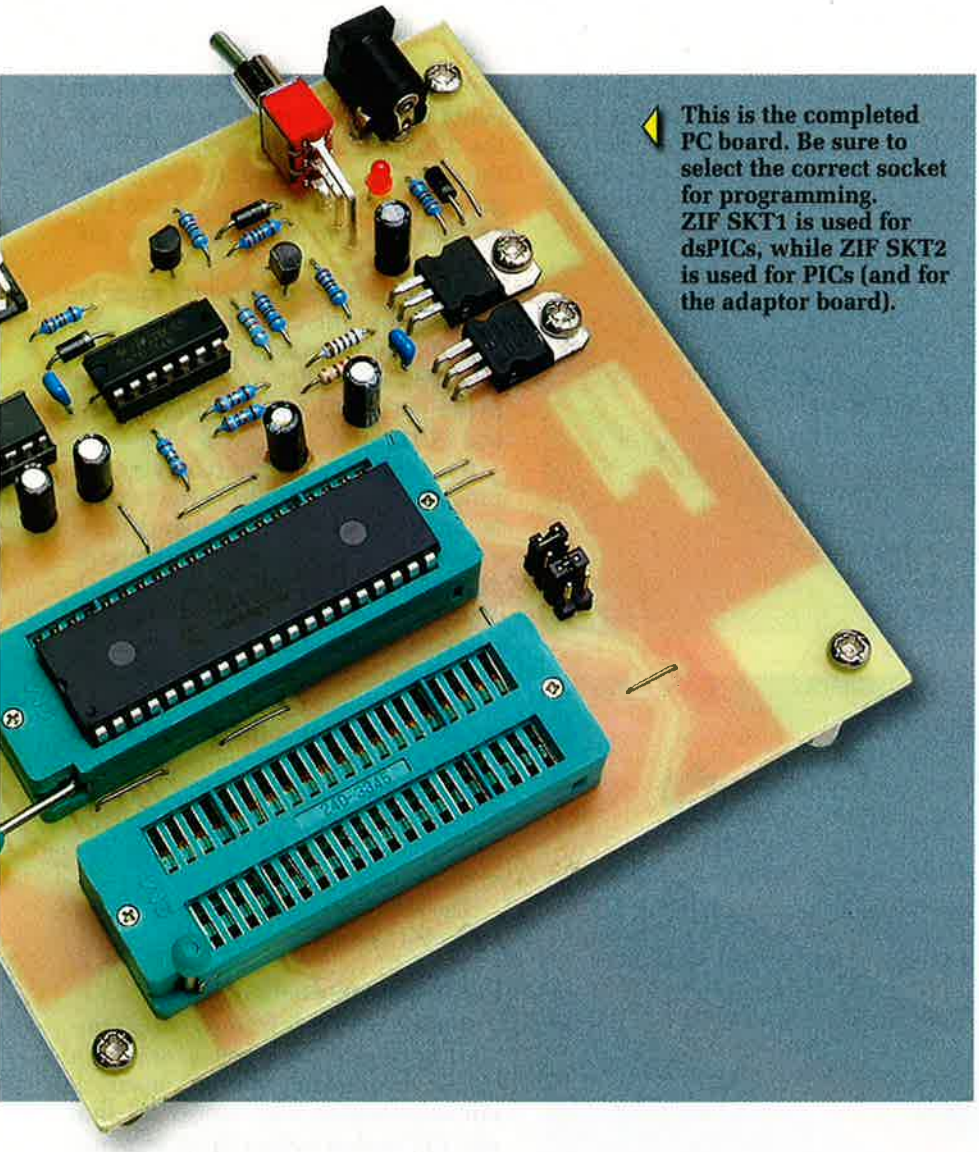
Jumper Number	Description
JP1	Short to make pin 8 of ZIF SKT1 the PGC pin
JP2	Short to make pin 8 of ZIF SKT1 GND
JP3	Short to make pin 4 of ZIF SKT2 the /MCLR/VPP pin
JP4	Short to make pin 1 of ZIF SKT2 the /MCLR/VPP pin

Warning: it is quite possible to damage a microcontroller installed in either ZIF socket by incorrectly setting jumpers JP1-JP4, so check Tables 2 & 4 carefully before inserting a microcontroller into its socket and applying power. However, a more likely outcome is that you will not damage the microcontroller (as they usually have protection diodes) but the programming will not be successful.

In summary, you must install either JP1 or JP2 (but NOT both) when programming a dsPIC and either JP3 or JP4 (but NOT both) when programming a PIC.

External Programming Using CON3

The 6-pin header CON3 can be used to program a PIC or dsPIC that's either mounted in-circuit on a separate board or installed on a breadboard. For example, this is one way of programming a PIC microcontroller that doesn't have



This is the completed PC board. Be sure to select the correct socket for programming. ZIF SKT1 is used for dsPICs, while ZIF SKT2 is used for PICs (and for the adaptor board).

a compatible pin-out with the ZIF sockets – see Table 4.

Devices that fall into that category include the 10Fxxxx and 12Fxxxx series of PICs, as well as some of the 16Fxxxx series.

The pin-outs for CON3 are shown in Table 1 and include the GND, +5V, MCLR-bar/V_{PP}, PGC and PGD lines. These are the only lines you will ever need to program your microcontroller.

If the microcontroller is on a powered board, you can ignore the +5V line (pin 5) and simply connect CON3's GND (pin 3 or 4) to the ground of your board. It's then simply a matter of connecting the MCLR-bar/V_{PP}, PGC and PGD lines to the appropriate pins on your PIC or dsPIC.

Optional Adaptor Board for 10F & 12F series PICs

We have also designed an optional adaptor board for 10F and 12F series PICs – see Fig.3. This adaptor plugs directly into ZIF SKT2 on the dsPIC/PIC Programmer and the position of the jumper on JP3 or JP4 is irrelevant when using the adaptor.

As shown in Fig.3, the adaptor has 20-pin and 8-pin IC sockets. The 8-pin socket is for 10F series PICs and the 20-pin socket is for 12F series PICs. As usual, the microcontroller to be programmed should be oriented so that its pin 1 is connected to the socket's pin 1. In addition, pin 1 of the adaptor board goes to pin 1 of ZIF SKT2.

You will need to refer to the microcontroller's datasheet and ensure that the pin-out is compatible with the ZIF socket by referring to the schematic diagram.

Construction

The dsPIC/PIC Programmer is built on a PC board coded 07105081 and measuring 122 x 120mm. The companion adaptor board is coded 07105082 and measures 52 x 19mm. Fig.2 shows the main board layout, while Fig.3 shows where the parts go on the adaptor board.

As usual, begin by checking the PC boards for defects, such as breaks in the tracks or shorts between adjacent tracks. It's rare to find any problems these days but it's still a good idea to check, as defects can be difficult to spot after the parts are installed.

Once these checks are completed, start the main board assembly by installing the 20 wire links. Use tinned copper wire for these links and make sure that they are nice and straight. You can straighten the link wire by clamping one end in a vice and these stretching the wire slightly by pulling on the other end with a pair of pliers.

Note that link LK7 goes under the RS-232 socket (CON2), while LK3 & LK6 are under ZIF SKT1.

Follow these with the 12 resistors. Table 1 shows the resistor colour codes to help you select the values but it is prudent to check each one using a DMM before it is soldered in place,

Table 3: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	6	2.2kΩ	red red red brown	red red black brown brown
❑	1	1.1kΩ	brown brown red brown	brown brown black brown brown
❑	1	120Ω	brown red brown brown	brown red black black brown
❑	1	82Ω	grey red black brown	grey red black gold brown
❑	3	39Ω	orange white black brown	orange white black gold brown

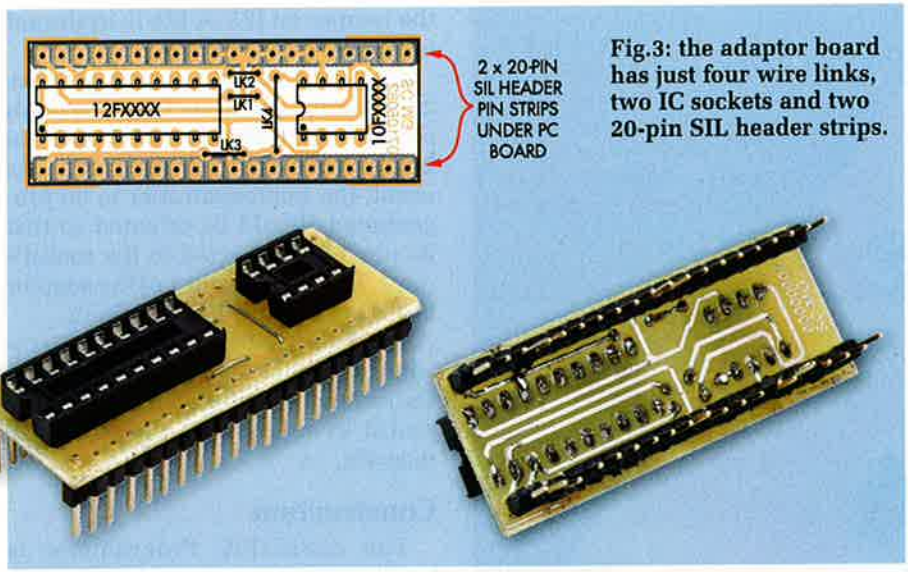
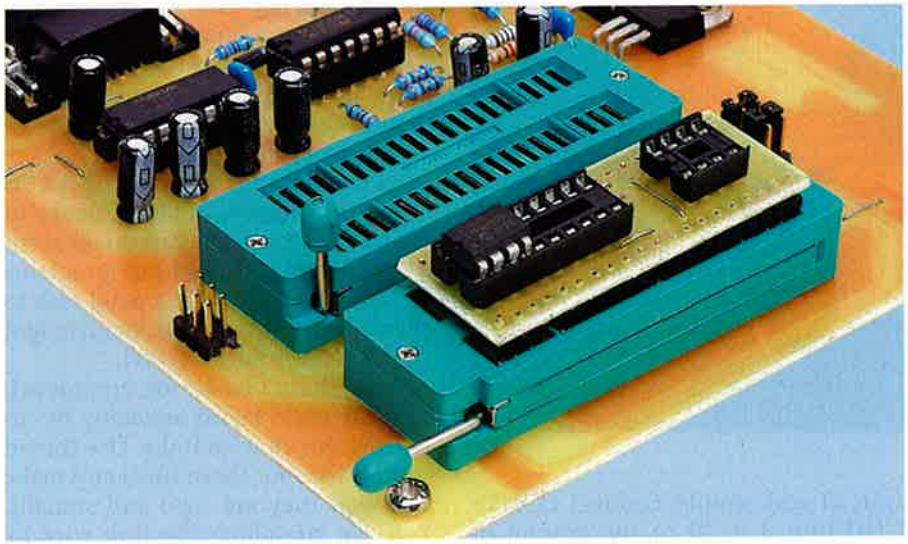


Fig.3: the adaptor board has just four wire links, two IC sockets and two 20-pin SIL header strips.



The adaptor board is used for programming 10F & 12F series PICs. As shown here, it plugs into ZIF SKT2 on the dsPIC/PIC Programmer board.

as some colours can be difficult to decipher.

The three diodes are next on the list. Be sure to install them with the correct polarity, as indicated on the parts layout diagram (Fig.2). Once they're in, install the two transistors, again making sure that they are correctly oriented.

Don't get the transistors mixed up. Q1 is a BC337 NPN transistor, while Q2 is a BC327 PNP type. Check that each is installed in its correct location.

Now for the capacitors: the ceramic and monolithic types are not polarised and can go in either way around. However, the electrolytic capacitors are polarised, so be sure to install them correctly.

The next step is to install IC sockets for IC1 & IC2. Again, make sure that these parts go in the right way around – ie, notched ends to the right. Note, however, that these sockets are optional. **Do not install the ICs at this stage – that step comes later, after the power supply has been checked out.**

Regulators REG1 & REG2 can now be mounted. These are both installed with their metal tabs flat against the PC board. To do this, first bend their leads down by 90° about 6mm from their bodies. That done, fasten each regulator to the PC board using M3 x 10mm screws and nuts, then solder their leads.

Do NOT solder the leads before bolting the devices down, as this could crack the soldered joints and damage the PC board as the nuts are tightened. Make sure also that each device is installed in its correct location.

All that remains now is to install the major hardware items. These include the 2.5mm DC power socket (CON1), the RS-232 connector (CON2), toggle switch S1, the 6-pin & 8-pin DIL pin headers and the two 40-pin ZIF sockets.

Note that the 8-pin header must be installed but the 6-pin header is necessary only if want to program a PIC or dsPIC externally and need access to the +5V, GND, MCLR-bar/V_{PP}, PGC and PGD lines!

Be sure to install the two large 40-pin ZIF sockets with the correct orientation. If you will only be programming a few microcontrollers occasionally, you can replace these with much cheaper IC sockets but the ZIF sockets make life much easier (and are worth the extra money in our opinion).

Finally, secure four M3 x 9mm spacers to the corner positions of the board using M3 x 6mm machine screws. These are used to support the board off the bench top during use. If you like, you can also fit four rubber feet to these spacers.

The dsPIC/PIC Programmer is now ready for testing.

Preliminary testing

Before using this new programmer, it should be given a thorough check. **Important: do not insert a microcontroller (PIC or dsPIC) into any ZIF socket before these tests are completed.**

A 16V DC plugpack should be used to power the dsPIC/PIC Programmer, although you can also probably use a 15V DC plugpack (just). Apply power and you should see the red indicator LED light. If it doesn't, check the supply polarity and if that's OK, check the polarity of the LED.

Assuming that the LED lights, the next step is to check the voltages at the outputs of the two regulators. You should measure +5V at the output of REG1 (anything from 4.8-5.1V is normal), while REG2's output should be close to 13.6V (13.4-13.8V is OK).

If REG's output is lower than 13.4V, increase the value of the 82Ω resistor (eg, to 120Ω) to bring it into the 13.4-13.8V range. Conversely, if the output is higher than 13.8V, decrease the value of the 82Ω resistor.

Alternatively, if REG2's output is outside the designated range, check the voltage between REG2's OUT & ADJ terminals. This value can then be

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used to calculate a new value for R2 from the formula given in the circuit description.

If the supply rails are correct, switch off and fit IC1 & IC2 to their respective sockets. That done, connect a serial cable between the programmer and your PC.

Adaptor board assembly

Fig.3 shows the parts layout for the adaptor board. It's a snap to assemble – just install the four wire links, the two IC sockets (watch their orientation) and the two 20-pin SIL pin headers.

Note that the pin headers are mounted on the copper side of the board. To install them, push their longer pins through until they sit flush with the top of the PC board, then initially solder just a pin at either end. The remaining pins can then be soldered, after which the plastic strips are slid down the pins until they rest against the soldered joints.

You are now ready to install the WinPIC software on your PC.

Software installation

As mentioned above, the software to use with this programmer is WinPIC, available from either **http://freenet-homepage.de/dl4yhf/winpicpr.html** or from the SILICON CHIP website at **www.siliconchip.com.au**. Once it has been downloaded, it's installed by running the executable file ***winpicsetup.exe***.

By the way, do not confuse WinPIC with other software that's available, such as WinPIC800. The latter is a completely different program and it will NOT work with this programmer.

Setting up WinPIC

After installing WinPIC, you should make sure that it is correctly set up to work with the programmer. Here's how to configure WinPIC:

(1) Start WinPIC and click on the "Interface" tab (see Fig.4);

(2) Ensure "COM84 programmer for serial port" is selected from the drop down menu;

(3) Ensure that the correct COM port is set;

(4) Check that both ZIF sockets are empty and that the programmer is connected to the PC via a serial cable;

(5) Apply power to the programmer and click on "Initialize!";

(6) In the "Options" tab, select either PortTalk or SMPORT (both are faster than using the Windows API). By contrast, if you wish to use a USB-RS232 converter cable, you are probably safer selecting the "no direct access at all, only use win API" option. This will be slower but will ensure that WinPIC accesses the correct windows drivers installed for your USB-RS232 converter. Refer to the section "Using USB-RS232 Converters" in the accompanying panel for more information.

Using A USB-RS232 Converter Cable

This dsPIC/PIC Programmer is designed to work with native RS-232 serial ports. However, many computers today, especially notebooks, do not have a serial port, as it has been superseded by USB.

Although USB-to-RS232 converter cables are available, not all will work correctly with this programmer. And for those that do work, programming may be considerably slower compared to working direct from a serial port.

The reason some converters don't work has to do with the low-level interface and the implementation of the USB-to-RS232 converter. In particular, the problem arises because some USB-to-RS232 converters are imperfect emulations of the serial port.

In normal use, pin 3 (Tx) of the RS232 serial port is the transmit line, used to send data at the selected baud rate. Most USB-to-RS232 converters will correctly emulate this, as it is necessary for full duplex data transmission.

However, COM84 style programmers like this one use pin 3 (Tx) of the serial port for the programming voltage and hence as a simple digital output. This is an unconventional use of the Tx line. It is accomplished in the WinPIC software by setting the "break" flag in the line control register (bit 6). However, some USB-to-RS232 converters (and their supplied software driver) do not emulate the break flag functionality and therefore will not work with this programmer.

USB-to-RS232 converters based on the newer FTDI chips, especially the FT232R, could possibly work, given that the specifications claim that the FT232R has inbuilt support for line break. It is, of course, up to the manufacturer of the USB-to-RS232 converter as to whether the full features of the interface ICs are supported through the supplied software driver.

If you would like to try a USB-to-RS232 converter with this programmer, you should make sure that it supports line break and that the "no direct access at all, only use Win API" option is selected in the "Options" tab of WinPIC. This means that WinPIC will not access the serial ports directly but only through the Windows API.

This ensures that WinPIC talks to the windows driver for your USB-to-RS232 converter, rather than trying to access ports that are not implemented. As indicated above, this may result in substantially slower operation than with a native serial port.

In our case, we tested the Prolific GUC-AD9 USB-RS232 converter on Windows XP and it worked. The only drawback was that it was slow – up to 10 times slower than when running the programmer direct from a serial port.

This is related to latencies in the windows API and the windows driver for the converter. A small delay (in the order of milliseconds) occurs when switching any control line and these small delays all add up to a considerable delay due to the huge number of switching requests made by WinPIC.

Note: the Prolific GUC-AD9 USB-RS232 converter is available from Jaycar (Cat. XC4834).

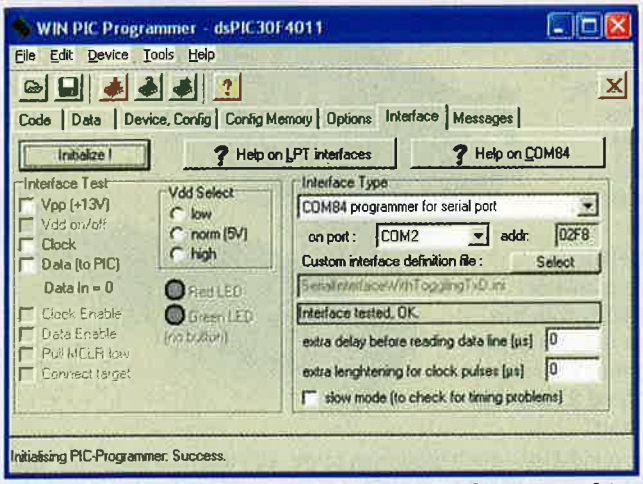


Fig.4: clicking the Interface tab in WinPic brings up this window. Ensure "COM84 programmer for serial port" is selected for the Interface Type and be sure to choose the correct COM port.

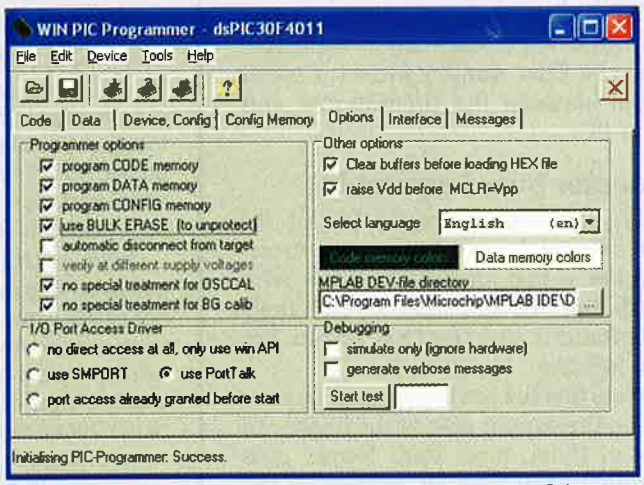

WIN PIC Programmer - dsPIC30F4011
File Edit Device Tools Help
Code Data Device, Config Config Memory Options Interface Messages
Programmer options
program CODE memory
program DATA memory
program CONFIG memory
use BULK ERASE (to unprotect)
automatic disconnect from target
verify at different supply voltages
no special treatment for OSCCAL
no special treatment for BG calib
I/O Port Access Driver
no direct access at all, only use win API
use SMPORT
use PortTalk
port access already granted before start
Other options
Clear buffers before loading HEX file
raise Vdd before MCLR=Vpp
Select language English (en)
Code memory colors
Data memory colors
MPLAB DEV-file directory
C:\Program Files\Microchip\MPLAB IDE\D
Debugging
simulate only (ignore hardware)
generate verbose messages
Start test
Initialising PIC-Programmer: Success.

Fig.5: after selecting the device to be programmed (see text) go to the Options tab and select the options shown here. The dsPIC or PIC can then be programmed as outlined in step 4.

Once the programmer has been initialised correctly by WinPIC, you are ready to program some PICs. Here's the procedure, step-by-step:

(1) Check that the power is off, then insert the PIC or dsPIC you wish to program into its corresponding ZIF socket (according to Table 4).

(2) Set the jumpers as indicated in Table 4. Note that either JP1 or JP2 (but NOT both) must be installed for dsPICs. Similarly, either JP3 or JP4 (but NOT both) must be installed for PIC microcontrollers, as set out in the table.

If these jumpers are incorrect, programming will almost certainly fail.

(3) Once the jumpers have been set, apply power, start WinPIC, go to ***Device –> Select*** and select the PIC or dsPIC you wish to program from the drop down menu. That done, go to the "Options" tab and select the options as shown in Fig.5.

(4) To program the dsPIC or PIC, go to ***File –> Load –> Program Device*** and select the hex file to be programmed. Note that the fuse bits should be within the hex file and they will be programmed as well.

WinPIC should now start to program your device and then verify its contents. You can use the "Code" tab to see the program memory.

If programming is successful, you should see the message "Programming finished, no errors" at the bottom lefthand corner of the window.

You can also erase, read and verify a microcontroller using WinPIC, although you should keep in mind that reading a code protected device will result in zero readings for the program memory bytes. For more detailed information on how to use WinPIC, refer to its help menu.

Finally, note that WinPIC accesses the serial port on your PC and requires real-time control of the programming signals. It is therefore possible that it will lock up while programming is in progress and fail to respond to mouse or keyboard commands.

To prevent this, avoid having other Windows programs running in the background while WinPIC is programming a device. If the WinPIC window stops responding when programming a device, simply wait for it to finish.

If everything is working correctly, you should see the message "Initialising PIC-Programmer: Success" at the bottom of the WinPIC window, as shown in Fig.5.

Troubleshooting

If you receive the message "WARNING: Could not initialize programmer!" instead, you can test the interface manually to narrow down the list of possible problems. Here's what to do:

(1) Clicking the "V_{PP}(+13V)" box should toggle pin 1 of CON3 (the external programming header) from 0V (box un-ticked) to around +12.5-13V (box ticked). If this doesn't happen, check that transistors Q1 & Q2 are the correct types. If they are, trace the signal from pin 3 of the serial port to pin 1 of CON3, checking at each stage that the signal toggles as this box is "ticked" and "un-ticked" in WinPIC.

(2) Clicking on the "Clock" box should toggle pin 2 of CON3 from 0V (un-ticked) to around +4-5V (ticked).

If that doesn't happen, check the MAX232 and its surrounding capacitors. That done, check the signal at pin 7 of the serial port, then at pins 13 & 12 of IC1, pin 1 of IC2, pin 2 of IC2 and finally pin 2 of CON3.

Note that the MAX232 (IC1) should level translate the signal level at pin 13 to about +5V at pin 12.

(3) Clicking on the "Data (to PIC)" box should toggle pin 6 of CON3 from 0V to around +3.5-5V and you should see the "Data In=" field change from 0 to 1. The latter should be 0 with the box un-ticked and 1 otherwise.

If this is not the case, check the signal at various points on the circuit from pin 4 of the serial port to pin 6 of CON3. Check also that pin 8 of the serial port is receiving the correct level (read by WinPIC and displayed in the "Data In=" field).

Read the FAQ

Finally, if the programmer is still not working, there could be issues with WinPIC. Refer to the online FAQ

Table 4: Setting Jumpers JP1,JP2 & JP3,JP4

Device	ZIF socket	JP1	JP2	JP3	JP4
10F200/202/204/206	Ext	N/A	N/A	N/A	N/A
12F508/509	Ext	N/A	N/A	N/A	N/A
12F609/615	Ext	N/A	N/A	N/A	N/A
12F629/675	Ext	N/A	N/A	N/A	N/A
12F635/636/639	Ext	N/A	N/A	N/A	N/A
12F675	Ext	N/A	N/A	N/A	N/A
12F683	Ext	N/A	N/A	N/A	N/A
16F610/616	Ext	N/A	N/A	N/A	N/A
16F627/627A/628/628A	ZIF SKT2	N/A	N/A	Short	Open
16F630/631/636/639/676/677/684/685/687/688/689	Ext	N/A	N/A	N/A	N/A
16F648/648A	ZIF SKT2	N/A	N/A	Short	Open
16F716	ZIF SKT2	N/A	N/A	Short	Open
16F73/737/74/76/77	ZIF SKT2	N/A	N/A	Open	Short
16F818/819	ZIF SKT2	N/A	N/A	Short	Open
16F84/84A/87/88	ZIF SKT2	N/A	N/A	Short	Open
16F870/871/872	ZIF SKT2	N/A	N/A	Open	Short
16F873/873A/874/874A/876/876A/877/877A	ZIF SKT2	N/A	N/A	Open	Short
16F913/914/916/917	ZIF SKT2	N/A	N/A	Open	Short
18F2220/2320/4220/4320	ZIF SKT2	N/A	N/A	Open	Short
18F2331/2431/4331/4431	ZIF SKT2	N/A	N/A	Open	Short
18F2420/2520/4420/4520	ZIF SKT2	N/A	N/A	Open	Short
18F2450/4450	ZIF SKT2	N/A	N/A	Open	Short
18F2455/2550/4455/4550	ZIF SKT2	N/A	N/A	Open	Short
18F2480/2580/4480/4580	ZIF SKT2	N/A	N/A	Open	Short
18F2525/26204525/4620	ZIF SKT2	N/A	N/A	Open	Short
18F2439/2539/4439/4539	ZIF SKT2	N/A	N/A	Open	Short
18F242/252/442/452/	ZIF SKT2	N/A	N/A	Open	Short
18F2585/4585/2680/4680	ZIF SKT2	N/A	N/A	Open	Short
18F248/258/448/458	ZIF SKT2	N/A	N/A	Open	Short
18F2682/2685/4682/4685	ZIF SKT2	N/A	N/A	Open	Short
dsPIC30F2010	ZIF SKT1	Open	Short	N/A	N/A
dsPIC30F2011/3012	ZIF SKT1	Short	Open	N/A	N/A
dsPIC30F2012/3013	ZIF SKT1	Open	Short	N/A	N/A
dsPIC30F3010	ZIF SKT1	Open	Short	N/A	N/A
dsPIC30F3011	ZIF SKT1	Short	Open	N/A	N/A
dsPIC30F3014/4013	ZIF SKT1	Short	Open	N/A	N/A
dsPIC30F4011	ZIF SKT1	Short	Open	N/A	N/A
dsPIC30F4012	ZIF SKT1	Open	Short	N/A	N/A

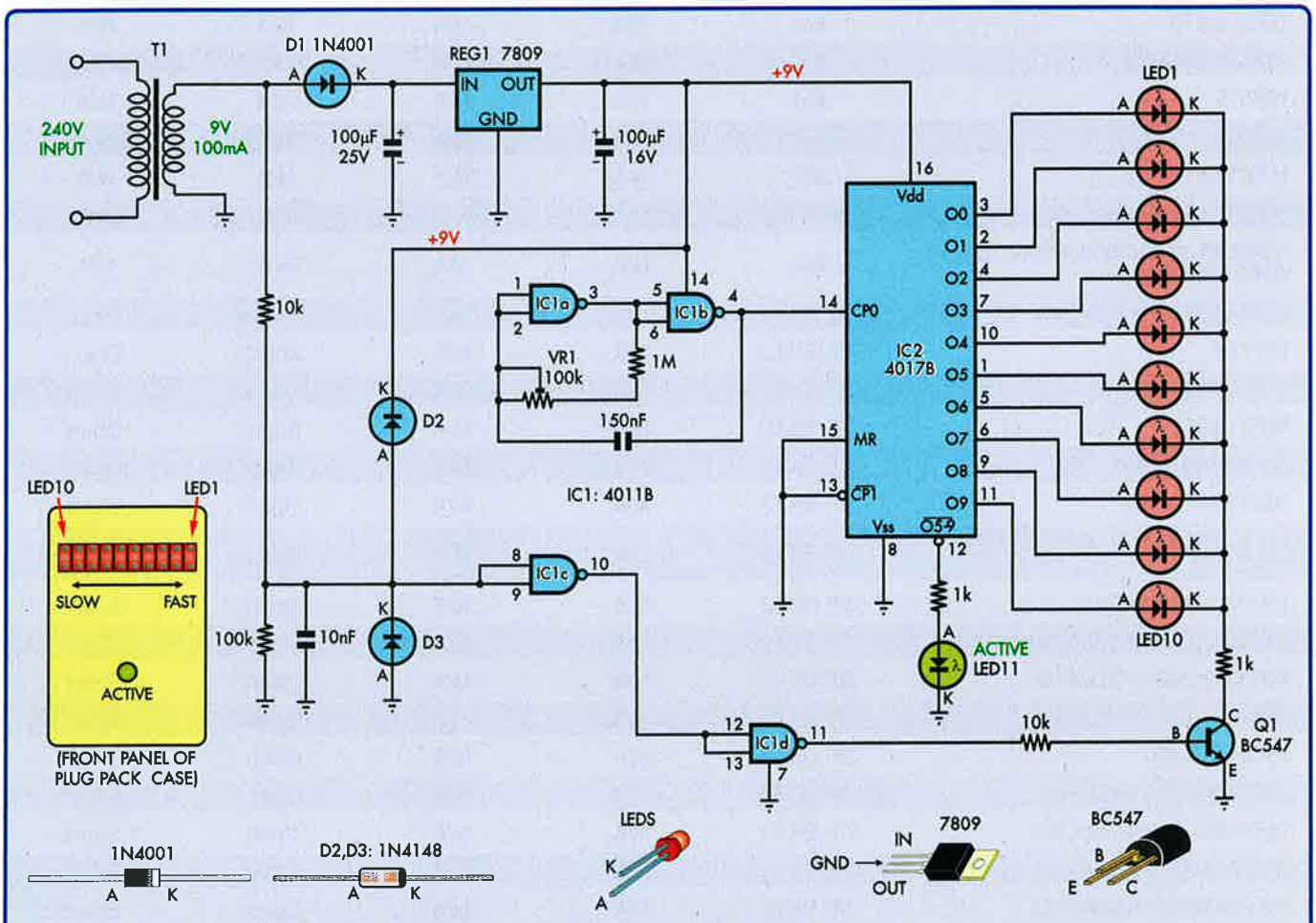
Ext = use an external programming header or the adaptor board.

at **http://freenet-homepage.de/dl4yhf/winpic/winpic_faq.htm** as a first resort if you are experiencing problems.

Because WinPIC tries to switch the programming lines in real time and because Windows is a multi-tasking operating system, timing problems could arise. For this reason, it is prudent to use the "slow mode" option in the "Interface" tab if you suspect there may be timing problems. **SC**

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Frequency indicator for generating equipment

This circuit was developed to adjust the operating speed (RPM) of portable AC generators. These usually have a speed-control knob but no means of determining the correct (50Hz) frequency. Since this sort of job is done outdoors, a digital frequency counter is not really justified and can be difficult to read, because of the typically long gating time at low frequencies.

Two NAND gates, IC1c & IC1b, are wired as a 500Hz oscillator and this clocks a 4017 decade counter, IC2. This drives 10 LEDs but only one will be on at any particular time, as the counter cycles through from 1-10. However, all the LEDs are connected to 0V via a common 1kΩ resistor and transistor Q1 which is turned on and off by a 50Hz signal derived from the generator.

If the 50Hz and 500Hz frequencies are precisely locked, the display will show a stationary LED. However, if the 50Hz signal is slightly high in frequency, the LED will appear to move in one direction and if the signal is slightly low, the LED will appear to move in the opposite direction.

The 50Hz 240VAC input from the generator is fed via transformer T1 and it powers the circuit via rectifier diode D1, a 100µF filter capacitor and a 7809 9V 3-terminal regulator (REG1). The 50Hz signal from the transformer is also fed via a 10kΩ resistor to a squaring circuit comprising gates IC1d & IC1c. This drives transistor Q1.

In use, the unit is plugged into the mains outlet of the portable generator and the governor speed of the engine is adjusted to give a stationary LED display. For 60Hz equipment, the oscillator would be set to 600Hz.

Note that the oscillator frequency should be adjusted precisely with the aid of an accurate frequency meter.

Dayle Edwards,
Taylorville, Westland, NZ. ($60)

siliconchip.com.au

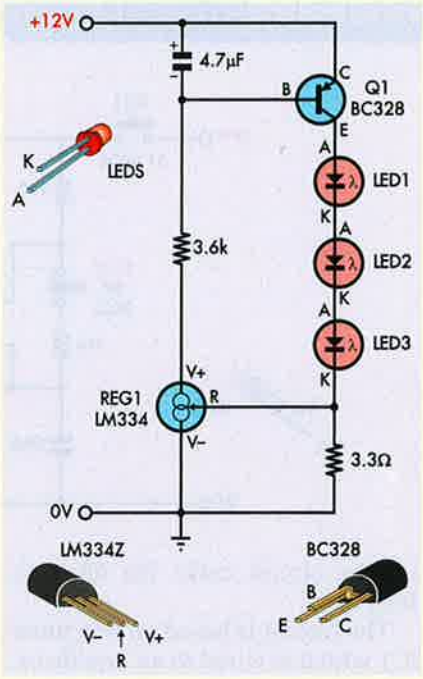
Josh Stevenson is this month's winner of a Peak Atlas Test Instrument

Constant-current LED navigation lights

This constant-current LED circuit has been used as the basis for a 24-LED navigation light on a yacht. The LEDs were arranged in two staggered rows around a 32mm plastic pipe placed in a small glass jar. For a 24-LED array, eight of these current sources will be required.

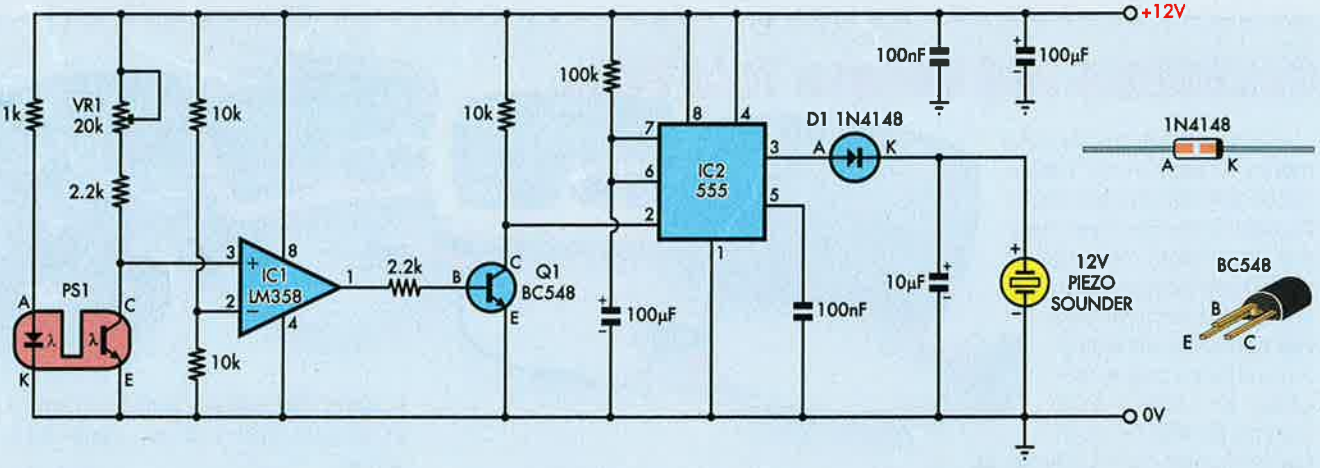
The LED drive circuit works as follows. The LM334 constant current source maintains a nominal 64mV between its "R" and "V-" terminals and it does this by adjusting the base current of transistor Q1 so that the collector current is 19.39mA. At this current, the voltage across the 3.3Ω resistor is maintained at 64mV and so the three series-connected LEDs are operated at a constant 19.4mA.

Four of these drive circuits were each built onto two circular pieces of Veroboard which were then stacked inside the glass jar. The 24 LEDs were then wired to the drive circuits.



The accompanying photos show how the assembly is wired and housed in the jar. The plastic lid needs to be painted with several coats of white acrylic to prevent deterioration due to UV exposure.

Josh Stevenson,
Kotare, NZ.



Optical smoke detector

This smoke detector circuit is based on a standard photo-interrupter as used in many computer printers. It contains an infrared LED facing a phototransistor across an air gap.

In this circuit, the collector of the phototransistor (PS1) is connected to +12V via a 2.2kΩ resistor and trimpot VR1. The collector also drives the non-inverting input (pin 3) of op amp IC1 which functions as a comparator.

Normally, the output from the infrared LED shines across the gap and turns on the phototransistor which pulls pin 3 of IC1 low. As a result, the comparator's output at pin 1 will be low and transistor Q1 will be off.

If enough smoke passes through the gap, the infrared LED's output will be blocked and pin 3 of IC1 will go high and so Q1 will be turned on. This will trigger a monostable timer based on 555 timer IC2 and this will sound the piezo buzzer for a time determined by the 100kΩ resistor and 100µF capacitor at pins 6 & 7. Trimpot VR1 is used as a sensitivity control.

A suitable photo-interrupter can be obtained from Jaycar (Cat. ZD-1901).

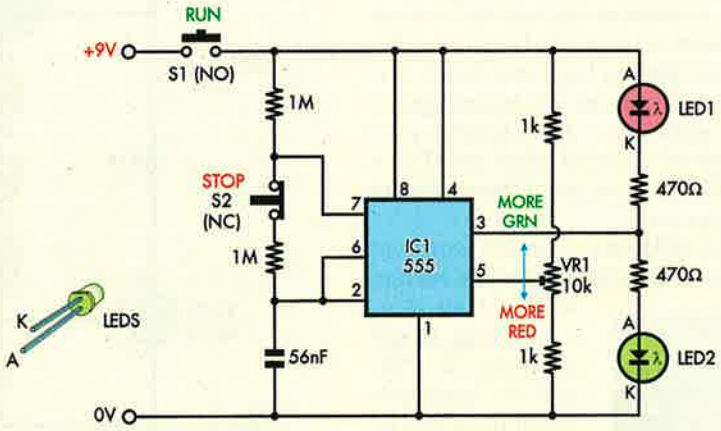
T. K. Hareendran,
Kerala, India. ($35)

Biased yes or no circuit

This may look like a simple coin toss or decision circuit but it is designed to enable you to increasingly say "No, I won't" when confronted with temptations to eat snacks or otherwise indulge appetites which increase your waistline, threaten your heart, imperil your lungs or endanger your driver's licence. It has two LEDs – green for "GO AHEAD" and red for "REFUSE".

Unlike other deciders which are designed to simulate coin tossing with even chances for heads or tails, this circuit has adjustable bias so that as you start your program to increase your resolve power, you can set it for a roughly even chance of yes or no but then as your "won't power" improves, you can bias it to increase the chance of a "REFUSE" answer.

So when temptation rears its ugly head, just press RUN switch S1 and let the circuit make the decision for you.



The circuit is based on 555 timer IC1 which is wired as an astable oscillator. This lights red LED1 when pin 3 is low and green LED2 when pin 3 is high.

When you press RUN switch S1, both LEDs flash rapidly until you stop the timer by pressing STOP switch S2. The slightly unusual placement of S2 in the circuit is necessary because the more usual positions altered the status of the output – which is not wanted.

The bias of the circuit is set by trimpot VR1. This could be a 10-turn type if you want fine adjustment. It acts as a mark/space ratio controller to give longer green or red outputs.

A. J. Lowe,
Bardon, Qld. ($35)

Contribute And Choose Your Prize

As you can see, we pay good money for each of the "Circuit Notebook" items published in SILICON CHIP. But now there are four more reasons to send in your circuit idea. Each month, the best contribution published will entitle the author to choose the prize: an LCR40 LCR meter, a DCA55 Semiconductor Component Analyser, an ESR60 Equivalent Series Resistance Analyser or an SCR100 Thyristor & Triac Analyser, with the compliments of Peak Electronic Design Ltd **www.peakelec.co.uk**

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24V & 6V versions of battery charge controller

Undoubtedly, some readers will want to use the Charge Controller from the April 2008 issue with a 24V or 6V charger. We are not in favour of this, since the adaptor has been optimised for 12V operation but here is how it could be done.

This partial version of the circuit shows the component changes needed (in red) for 24V operation. For 24V use, REG1 must be changed to an LM317HV to cope with the higher input voltage; a 1N4004 diode must be connected between the input and output of REG1 (anode to the output, cathode to the input); ZD1 must be changed to two 24V zener diodes in series; and the 470µF and 10µF capacitors at the input to REG1 must be 50V types. In addition, R1 and R2 should be 130kΩ and 24kΩ respectively. This changes the division ratio so that IC1 sees the voltages for a 12V battery.

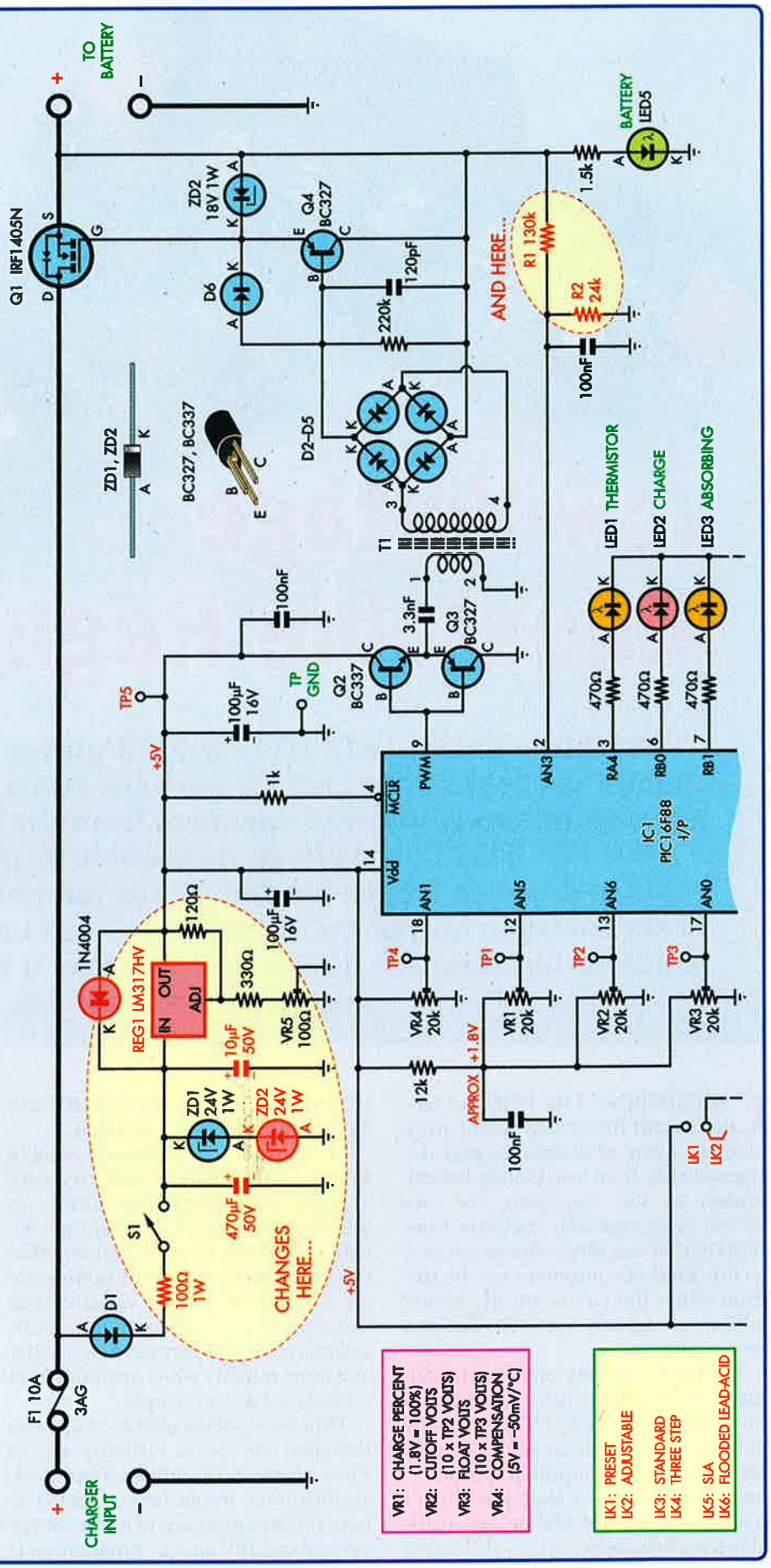
Note that when setting the adjustable values, use voltages that are 0.5 of the required value. So a 30V cut-off would be set for 15V (1.5V on VR2). Similarly, a -50mV/°C temperature compensation would be set at -25mV using a 2.5V setting for VR4.

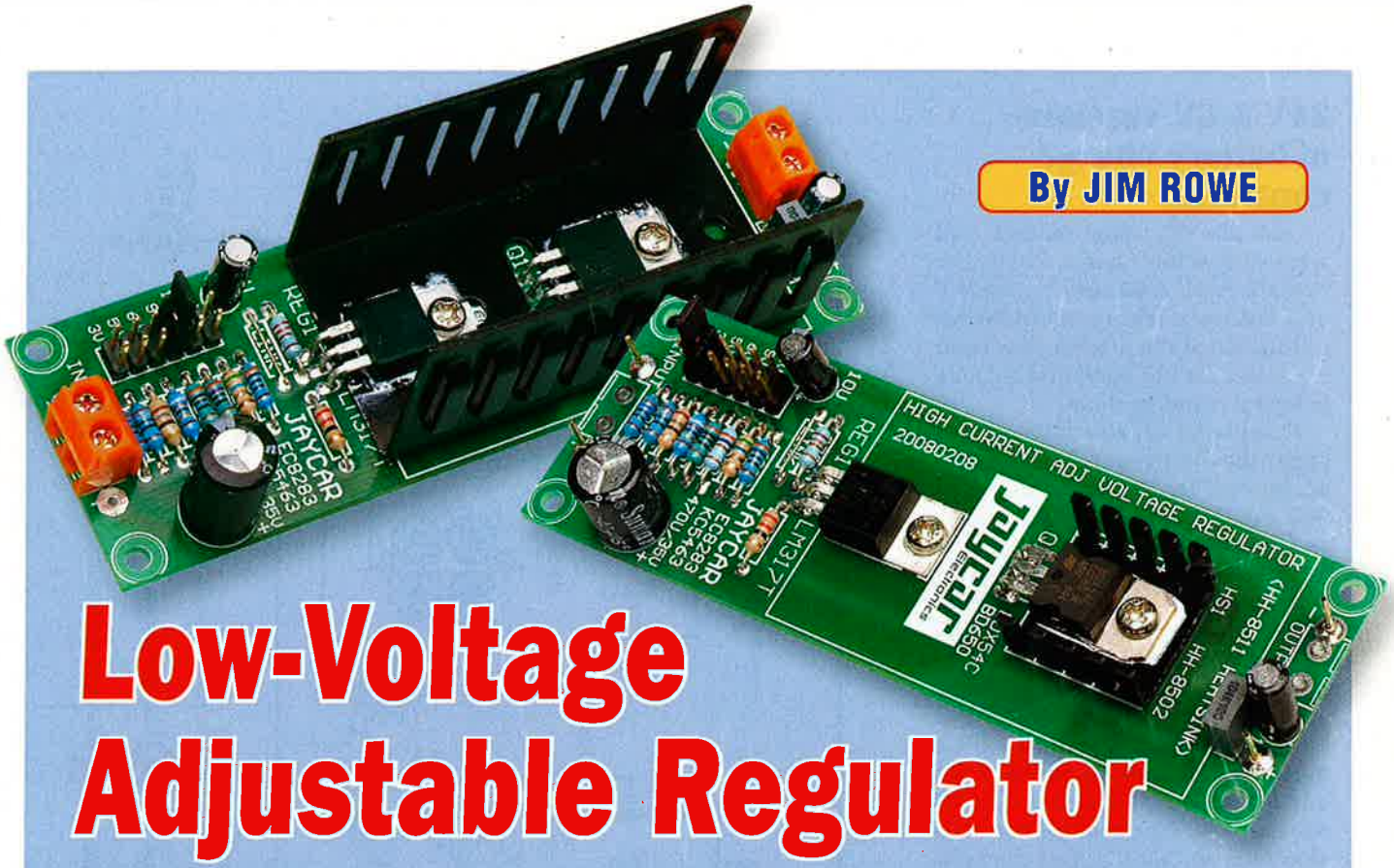
For 6V operation, use a low dropout adjustable regulator (LD1117V) for REG1, a 10Ω resistor instead of the 100Ω resistor supplying REG1, and a 15V zener for ZD1. R1 should be 22kΩ and R2 should be 10kΩ.

In the 6V case, you must only use the adjustable parameters because the preset ones are for 12V batteries. You must use a 6V charger and the 6V battery must not be much less than 6V unloaded.

When the cut-off voltage for the selected charge cycle is less than 12V, the burst charging for a flat battery that's at less than 10.5V becomes inoperative. This enables the 6V charging. The adjustable cut-off and float voltages are set at, for example, 7.2V and 6.9V respectively, with 0.72V and 0.69V at TP2 and TP3 respectively. The temperature compensation is set to the mV/°C value for the battery.

John Clarke, Silicon Chip.





Low-Voltage Adjustable Regulator

By JIM ROWE

Need to operate a CD, DVD or MP3 player from the cigarette lighter socket in your car? Or perhaps run a digital still or video camera or some powered speakers from the power supply inside your PC? This Low-Voltage Adjustable Regulator will step the voltage down to what's needed. It has jumper shunts to select one of six common output voltages (from 3-15V) and depending on the input voltage and the heatsink(s) you use, it can deliver an output current of just over 4A.

CONSIDERING THE PRICE of batteries and the ever-growing array of small items of electronic gear designed to run from low-voltage battery power, it's not surprising that one of the most common requests from SILICON CHIP readers is for an adaptor so this kind of equipment can be run from either the power supply inside a PC or a cigarette lighter socket in a motor vehicle.

Most of the battery-operated equipment we're talking about is designed to operate at 3V, 6V or 9V whereas the voltages available from vehicle batteries or PC power supplies are rather more restricted. For example, there's usually only either 12V or 24V available from vehicle batteries, while most PC power supplies only have 5V and 12V supplies readily available.

In addition, the voltage available from a vehicle battery can vary over a fairly wide range depending on whether the engine is running, the battery is being charged and whether the lights and/or air conditioning are on. This sort of voltage variation can cause problems for electronic circuits, as these generally perform much better and more reliably when operated from a regulated power supply.

This low-voltage adaptor has been designed for use in virtually any of these common DC voltage step-down applications. It can be connected to any convenient source of input voltage up to about 28V and is "programmed" using a push-on jumper shunt to deliver one of six output voltages: 3V, 5V, 6V, 9V, 12V or 15V. In each case the output voltage is well regulated, remaining very close to the selected voltage despite broad changes in both input voltage and load current level.

Circuit description

The circuit is shown in Fig.1. The heart of the adaptor is an LM317T adjustable 3-terminal regulator which comes in a TO-220 package. The LM317 is designed to maintain the voltage between its output (OUT) and adjustment (ADJ) terminals at close to 1.25V. At the same time, the current level through its ADJ terminal is maintained at a very low level (typically

50µA) and varies by less than 5µA over the full rated load current range (10mA - 1.5A) and the input-output voltage range of 3-40V.

The LM317's actual regulated output voltage can be varied over a wide range using a simple resistive voltage divider. As shown in Fig.1, the divider's top resistor is connected between the OUT and ADJ terminals of REG1, while the bottom resistor is connected between the ADJ terminal and the negative voltage rail.

Since the LM317 maintains the voltage across the upper resistor at 1.25V, the total output voltage can be set for virtually any voltage above this level simply by adjusting the value of the lower divider resistor. The value of the lower resistor is found by taking into account that it needs to drop the desired output voltage minus 1.25V, while carrying the current passing through the upper resistor plus an additional 50µA (from the ADJ terminal).

In our circuit, the upper divider resistor is 120Ω, giving a nominal current of 1.25/120 = 10.42mA. Hence the current through the lower divider resistor is 10.42 + 0.05 = 10.47mA.

The value of the lower divider resistance is varied using the jumper shunt to link one of the six "voltage select" pin pairs. For example, when the shunt is fitted in the 3V position, the lower divider resistor is 160Ω, while when it's fitted in the 6V position the lower resistor value is set to (160 + 180 + 18 + 91) = 449Ω. The resistor values selected by each of the jumper shunt positions have been calculated to give LM317 output voltages as close as possible to the marked values, using standard resistor tolerance values.

Current boost

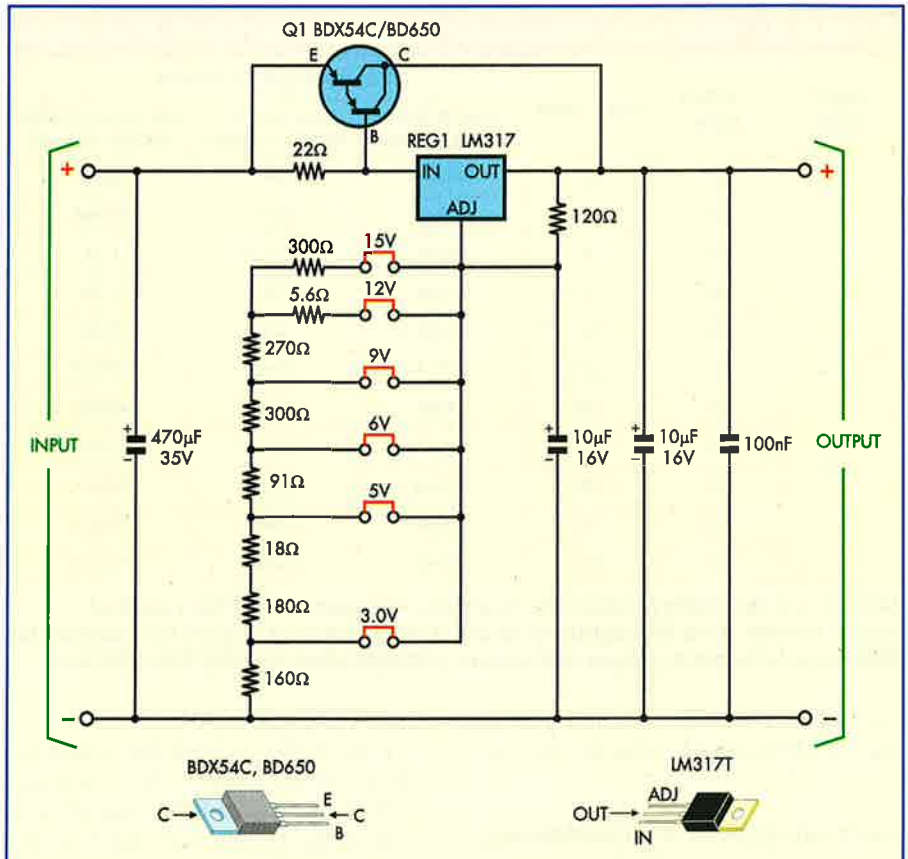
So that is how we set the output voltage. However, since the LM317 can only cope comfortably with currents up to around 1.5A, it needs a boost if the adaptor is to supply higher currents. In our circuit, this boost is provided by Q1, a BDX54C/BD650 PNP Darlington power transistor.

Q1 has its emitter and base connected across the 22Ω resistor in series with the LM317's input. As a result, the voltage developed across the 22Ω resistor when the LM317 draws current provides Q1 with forward bias.

When the current drawn by the load through the LM317 rises to about 55mA, the voltage drop across the 22Ω resistor will be around 1.2V. This is enough to forward bias Q1 into conduction. As the load current rises above this 55mA level, Q1 gradually takes over from the LM317 and handles more and more of the load current. The higher the load current, the greater the proportion that's handled by Q1.

The current boost provided by Q1 doesn't degrade the voltage regulation performance of the LM317. The regulator still controls the output voltage level closely in the normal way and varies the current passing through Q1 by varying its own current. In effect, Q1 acts purely as a slave to REG1, boosting the total output current capacity.

The function of the 470µF capacitor across the adaptor's input is to provide a degree of smoothing and filtering, to minimise the effect of any alternator noise or power supply ripple which may be present on the input voltage. Further filtering is provided by the 10µF capacitor which is connected between the LM317's ADJ terminal and



SC ©2008 **HIGH CURRENT ADJUSTABLE REGULATOR**

Fig.1: the circuit is based on an LM317 adustable regulator and a PNP Darlington transistor (Q1) to boost the output current capability. The output voltage is set by the resistive voltage divider string on the regulator's OUT and ADJ terminals and depends on the jumper shunt installed.

Specifications

- **Selectable output voltage:** 3V, 5V, 6V, 9V, 12V or 15V DC within ±3%
- **Output voltage regulation:** typically better than 0.5% up to 500mA; better than 1% for output currents up to 1A
- **DC Input voltage:** up to 24V battery
- **Output current:** up to 4.25A – see Table 1.

Table 1: Voltage Adaptor Output Current Ratings

Input Volts	Output Volts	Vin – Vout	Maximum output current		
			With HH-8502 heatsink (on board)	With HH-8511 heatsink (on board)	With Q1 on HH-8566 heatsink, off board
6V	3V	3V	830mA	2A	2.8A
12V	3V	9V	275mA	660mA	940mA
	5V	7V	350mA	850mA	1.2A
	6V	6V	415mA	1A	1.4A
	9V	3V	830mA	2A	2.8A
24V	3V	21V	115mA	280mA	400mA
	5V	19V	130mA	310mA	440mA
	6V	18V	135mA	330mA	470mA
	9V	15V	160mA	400mA	560mA
	12V	12V	200mA	500mA	700mA
	15V	9V	275mA	660mA	940mA

Table 1: use this table to select the heatsink necessary to suit the required output current from the regulator board. Note that you also have to consider the difference between the input and output voltages when making this selection.

the negative voltage rail, and also by the 100nF and 10µF capacitors across the output.

Current, power & heatsinking

Before we turn to the construction of the adaptor, it's important to understand how the amount of load current is determined by two factors: (1) the difference between the input voltage and the selected output voltage; and (2) the amount of heatsinking fitted to current booster Q1 (and to a lesser extent, regulator REG1).

These things are all linked together because the main limitation on the adaptor's maximum output current is the heat dissipation in both Q1 and REG1. Q1 can only dissipate a little over 20W for case temperatures up to 100°C, while REG1 has internal overcurrent and over-temperature protection which limits its power dissipation to less than about 15W.

These limits control the adaptor's output current because the case temperatures of Q1 and REG1 are proportional to the power they have to dissipate, and their power dissipation is determined in turn by the voltage they have to drop (ie, the difference between the adaptor's output and input voltages) multiplied by the output current.

We can express this mathematically using the following equation:

$$P(tot) = I(load) \times (V_{in} - V_{out})$$

where P(tot) is the total power dissipation in watts, I(load) is the load current in amps and V_{in} and V_{out} are the adaptor input and output voltages respectively.

So the important point to grasp is that the larger the voltage difference ($V_{in} - V_{out}$), the smaller the maximum load current that the adaptor can handle.

Just how hot Q1 and REG1 actually get for a given amount of power dissipation depends on the heatsink size. To be precise, the temperature rise for each device is determined by the power being dissipated and the 'thermal resistance' between its internal junction and the surrounding "ambient", as follows:

$$T(case - ambient) = P(tot) \times R(j-a)$$

where T(case - ambient) is the case temperature rise above ambient and R(j-a) is the thermal resistance between the junction and ambient. The latter is made up from two thermal resistances in series; the junction to case thermal resistance and the thermal resistance from case to ambient:

$$R(j-a) = R(j-c) + R(c-a)$$

where R(j-c) is the internal thermal resistance from junction to case, which is around 4°C per watt for TO-220 devices like Q1 or REG1. R(c-a) is the thermal resistance from case to ambient, which we can lower by fitting the device with a heatsink.

For example, the thermal resistance R(c-a) of a TO-220 device like Q1 without any heatsink at all is around 46°C/watt, so its temperature will rise above ambient by about (4 + 46) = 50°C for every watt of power it must dissipate.

If we fit it with even a small heatsink like the Jaycar HH-8502, this drops R(c-a) to 20°C/watt, lowering the total temperature rise above ambient to (4 + 20) = 24°C for each watt of power dissipated. So fitting this small heatsink on Q1 will roughly double the adaptor's power dissipation ability.

We can do much better if we fit Q1 with a larger heatsink like the Jaycar

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	300Ω	orange black brown brown	orange black black black brown
❑	1	270Ω	red violet brown brown	red violet black black brown
❑	1	180Ω	brown grey brown brown	brown grey black black brown
❑	1	160Ω	brown blue brown brown	brown blue black black brown
❑	1	120Ω	brown red brown brown	brown red black black brown
❑	1	91Ω	white brown black brown	white brown black gold brown
❑	1	22Ω	red red black brown	red red black gold brown
❑	1	18Ω	brown grey black brown	brown grey black gold brown
❑	1	5.6Ω	green blue gold brown	green blue black silver brown

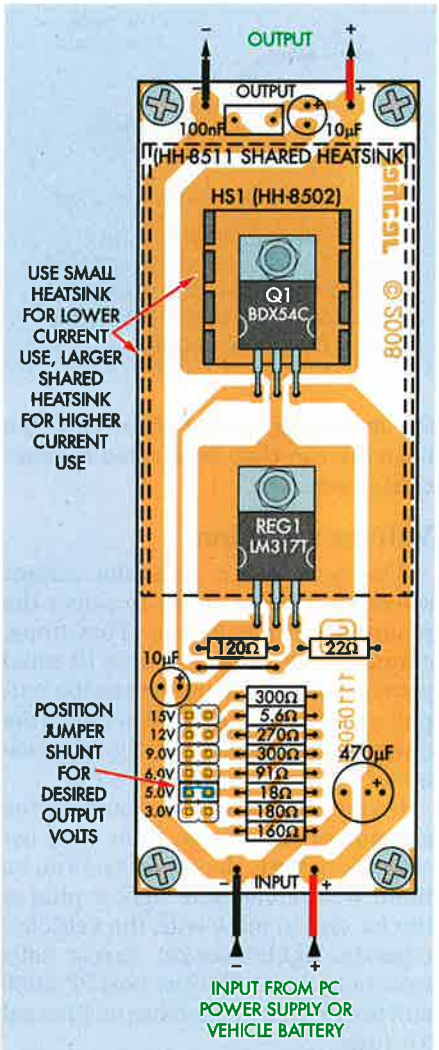


Fig.2: install the parts on the PC board as shown here. The output voltage is set by installing a jumper shunt in one of the link positions.

HH-8511 (which can be shared with REG1 as the latter doesn't dissipate much power). The larger heatsink reduces R(c-a) to 6°C/watt, resulting in a total temperature rise of only (4 + 6) = 10°C for each watt dissipated.

It is possible to reduce the value of R(c-a) even further by fitting Q1 with an even larger heatsink, to allow it to dissipate even more power. However this involves mounting Q1 off the adaptor's PC board.

To summarise, if you want the adaptor to supply as much current as possible, you must limit (V_{in} - V_{out}) by reducing V_{in}. **However, V_{in} must be at least 3V higher than V_{out} for the adaptor to work correctly.**

If you're stuck with a particular input voltage (say 12V), the only way to increase the adaptor's output current capability is to provide Q1 with a larger heatsink, as just discussed.

Example

Let's say you want to use the adaptor to power a portable CD player from the cigarette lighter socket in your car and the CD player needs 3V DC. So V_{in} is 12V and the adaptor will have to drop 12 - 3 = 9V.

Now let's assume that Q1 is fitted with just a small HH-8502 heatsink. What current will it be able to deliver to the CD player at ambient temperatures up to 40°C?

From what we've seen above, the total R(j-a) for Q1 with this small heatsink is around 24°C/watt, so if we want its temperature to rise by no more than 60°C above an ambient of 40°C (ie, to 100°C maximum), the maximum power that Q1 should be called upon to dissipate is 60/24 = 2.5W. If the adaptor will be dropping 9V, this corresponds to a maximum load current of 2.5/9, or about 275mA (power = voltage x current, so current = power/voltage).

If the CD player needs to draw more current than this, you'll have to fit Q1 with a larger heatsink like the HH-8511 which allow it to deliver 6/9 amps, or about 660mA.

If this current rating seems pretty low, consider that this example is for a very demanding situation where it is being called upon to deliver the lowest selectable output voltage but from a fairly high input voltage.

For an easier example, let's say you want to provide a radio or some other equipment with 9V but still want to run the adaptor from 12V. This will mean that Q1 will only have to drop (12 - 9 = 3V). So with the smaller HH-8502 heatsink it would be able to deliver up to 2.5/3 or 830mA. Alternatively, with the larger HH-8511 heatsink, it would be able to supply 6/3 or 2A.

To make it easier to choose which size of heatsink you need for your application, refer to Table 1 for the most likely combinations of input voltage and output voltage. Note that only practical combinations are shown – ie, where the input is at least 3V higher than the output, so that the unit can operate correctly.

Construction

All the parts used in the adaptor mount on a small PC board measur-

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Parts List

1 PC board, code 11105081, 107 x 39mm
1 HH-8502 19mm square TO-220 heatsink, OR
1 HH-8511 61 x 36 x 30mm 'U' heatsink
2 TO-220 silicone washers
1 6x2 length of DIL jumper strip
1 jumper shunt
2 M3 x 6mm machine screws
2 M3 nuts
4 PC board terminal pins, 1mm diameter

Semiconductors

1 LM317T regulator (REG1)
1 BDX54C or BD650 PNP power Darlington (Q1)

Capacitors

1 470µF 35V RB electrolytic
2 10µF 16V RB electrolytic
1 100nF MKT metallised polyester

Resistors (0.25W 1%)

2 300Ω	1 91Ω
1 270Ω	1 22Ω
1 180Ω	1 18Ω
1 160Ω	1 5.6Ω
1 120Ω	

Where To Buy A Kit

This project was developed by Jaycar Electronics and they own the copyright on the PC board. Kits will be available exclusively from Jaycar retail outlets and dealers (Cat. KC-5463) and will be supplied with the HH-8502 heatsink.

ing 107 x 39mm. The component overlay diagram is shown in Fig.2. Begin assembly by fitting the four PC board terminal pins (to the external wiring points) and the 6x2 length of DIL jumper strip used for the output voltage programming. Follow these with the single wire link that goes just below the 120Ω resistor.

Next, fit the 10 resistors to the board, taking care to place each one in its correct position. Table 1 shows the resistor colour codes but you should also check each resistor using a DMM before soldering it in, as some of the colours can be difficult to decipher.

After the resistors you can install the capacitors, starting with the unpolarised 100nF MKT capacitor up at the top/output end. Follow this with the three electrolytic capacitors, taking care to fit each of these the correct way around because they are polarised.

The next step is to fit the heatsink (either the HH-8502 or the larger HH-8511 – see Table 1), along with REG1 and Q1. Each of the latter two devices is mounted "flat" with its leads bent down by 90° about 6mm from its case, so they pass through the relevant holes in the PC board.

If you're just using the small HH-8502 heatsink for Q1, REG1 can be fitted directly to the board (ie, no heatsink) and its metal tab secured using an M3 x 6mm machine screw and nut. The machine screw and nut also provide REG1 with a small amount of incidental heatsinking, in conjunction with the copper square underneath.

Once you've secured its tab, its leads can be soldered to the copper pads under the board. Don't solder the leads before bolting down the tab – you could stress and crack the solder joints if you do.

Q1 is mounted on the top of its heatsink, using a thermal conducting washer or a smear of thermal compound to ensure a good thermal bond. An M3 x 6mm screw and nut are then used to secure the assembly in place, before soldering Q1's leads to their pads underneath.

Alternatively, both Q1 and REG1 can be mounted on the larger HH-8511 heatsink, again using either thermal conducting washers or smears of thermal compound to ensure good thermal bonds. As before, bolt the assembly to the PC board before soldering the device leads.

Voltage on the heatsink

It is not really necessary to electrically isolate the metal tabs of Q1 and REG1 from each other (or from the heatsink), since they both sit at the output voltage (ie, Q1's tab is its collector and REG1's tab is its output terminal). **It does mean, however, that the heatsink also operates at the output voltage when power is applied, so make sure it doesn't short against other equipment.**

This is also an important consideration if you mount Q1 off the board on a large external heatsink. In that case, you might want to electrically isolate Q1 from the heatsink using a TO-220 insulation kit (ie, thermal insulation washer plus insulating bush for the mounting screw). That way, the heatsink can then be earthed to other equipment.

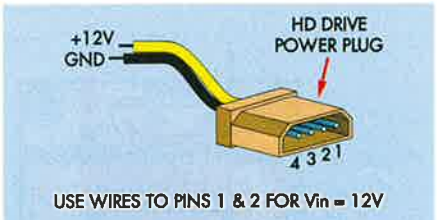

Fig.3: a hard disk drive power connector (eg, Jaycar PP-0743) can be used to connect the input of the regulator board to the 12V output from a PC power supply.

Voltage selection

The next step is to fit the voltage selection jumper shunt to select the required output voltage. That done, connect a DC power source (it must provide at least 3V more than the output voltage you want), then check the output voltage with your digital multimeter. It should be within ±3%.

If you are going to be sourcing the adaptor input voltage from your car or truck battery, the input lead can be fitted with a cigarette lighter plug at the far end to mate with the vehicle's cigarette lighter socket. Jaycar sells two such plugs – the low-cost PP-2000 and the PP-2001 which has an internal 3A fuse.

Similarly, if you intend sourcing the adaptor's input voltage from a PC power supply, the input lead can be fitted with a 4-way plug (as used on the rear of hard disk drives), to mate with a spare power connector inside the PC. Again Jaycar can provide two versions of these plugs: the PP-0743 or the PP-0744.

Fig.3 shows the connections for using this type of plug to provide a 12V supply for the regulator board. Note, however, that this input voltage will only be suitable for output voltages up to 9V.

Output connector

The adaptor's output lead can be fitted with a power connector to suit the device or devices you're going to be powering. In many cases this is likely to be a concentric low-voltage DC connector.

Finally, when mounting the adaptor inside a case, make sure it has adequate ventilation to dissipate the likely heat it will produce. SC

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Vintage Radio

By RODNEY CHAMPNESS, VK3UG

The versatile multi-band Ferris 174 portable

Radio sets were expensive 50 years ago, so sets that could take on the combined role of a car radio, a domestic receiver and a personal portable found a ready market. One such set was the multi-band Ferris 174 8-transistor radio.

MOST OF THE larger Australian radio and TV manufacturers, including AWA, HMV and Astor, concentrated on producing items that were sold in their thousands. Before the advent of TV, these products were mainly four and 5-valve radios, either 240V mains-operated or broadcast-band valve portables. In addition, several manufacturers produced some outstanding car radios.

Commercial production of mains-operated TV receivers began in 1956 and again the manufacturers concentrated on items that would sell in large quantities. Previously, they had produced radios to suit AC/DC mains, some fine 32V receivers and a few high-quality multi-band receivers but when it came to TV sets, no 12V or 32V-powered receivers were made locally.

In those days, there was a strong demand for electronic equipment – radios mostly – that could be used by people in rural areas where there was no mains power. Radios in the 1950s, 60s and 70s were still relatively expensive and a set that could be used in many different situations would be an attractive product.

In particular, a radio that could be used as a household receiver, a car radio and a portable receiver would find a ready market. It would cost more than a conventional set but it would still work out cheaper than having to buy three separate sets.

Ferris radios

Fortunately, one Australian manufacturer, Ferris Brothers Pty Ltd, stepped into this niche market. Ferris was not a mainstream manufacturer and did not concentrate on the common four or 5-valve mantel receivers of the era. Instead, it was a specialised manufacturer that produced many innovative radio and allied electronic products.

Ferris Brothers commenced business around 1934 and subsequently specialised in car radios. However, the Australian Official Radio Service Manuals (AORSM) do not list any Ferris sets until 1946, so Ferris was probably quite a small manufacturer up until that time.

Their products became more readily available after World War II and by 1947 they were producing a car radio that could not only be powered from a 12V battery but from 240V AC as well. It featured an elementary noise limiter, as did a bus radio that came out in the same year.

By 1949, the company was producing a 3-band car radio cum domestic

receiver complete with noise limiter. The engine bay layouts of vehicles from that period were not conducive to minimising spark ignition noise, so noise limiters were a necessary feature of such sets.

In 1955, Ferris started building AC/battery-powered portables which had provision to plug in a car radio antenna. They subsequently found that, with the advent of transistors, they could make radios that were truly portable. These sets could also be used as car radios when plugged into a cradle or they could be laid on the seat in a safety bracket – rather like a seat belt for radios (and well before they became compulsory for humans)!

As with their earlier sets, these new sets were designed to connect to a car's radio antenna.

Many such sets were also considered suitable for use as domestic receivers, as they had quite a large battery fitted. Some also featured shortwave reception so that those people in remote areas could at least listen to the ABC's shortwave inland service. These sets were also of considerable interest to people interested in listening to shortwave radio as a hobby.

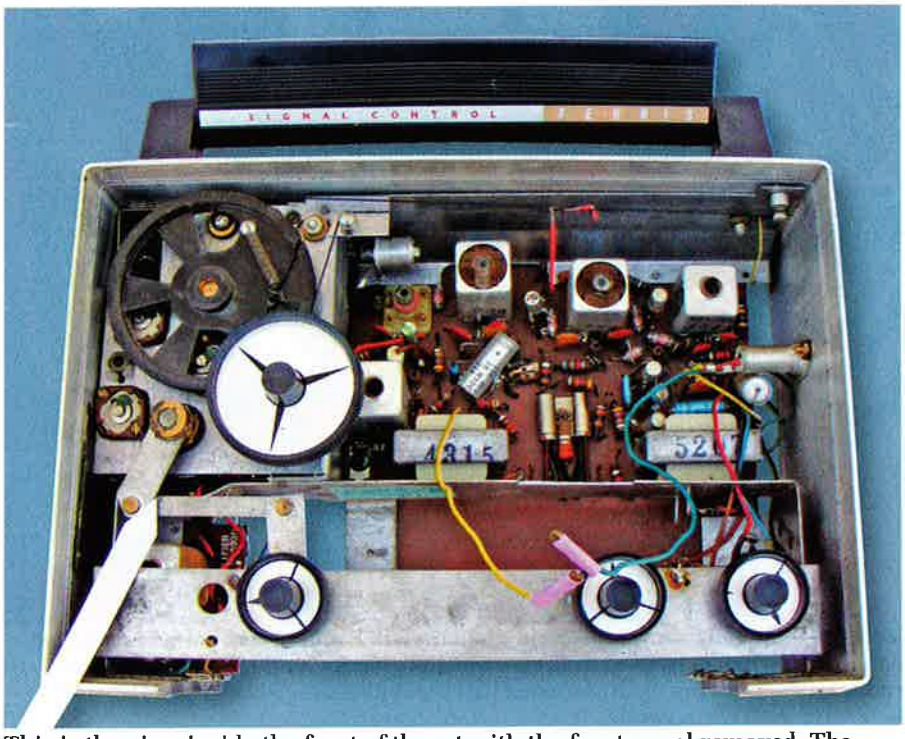
This ABC's inland service, by the way, was disbanded several years ago and replaced by the "HF Shower" service. It emanates from Alice Springs, Tennant Creek and Catherine and broadcasts on the 2MHz and 4MHz bands.

The Ferris 174 receiver

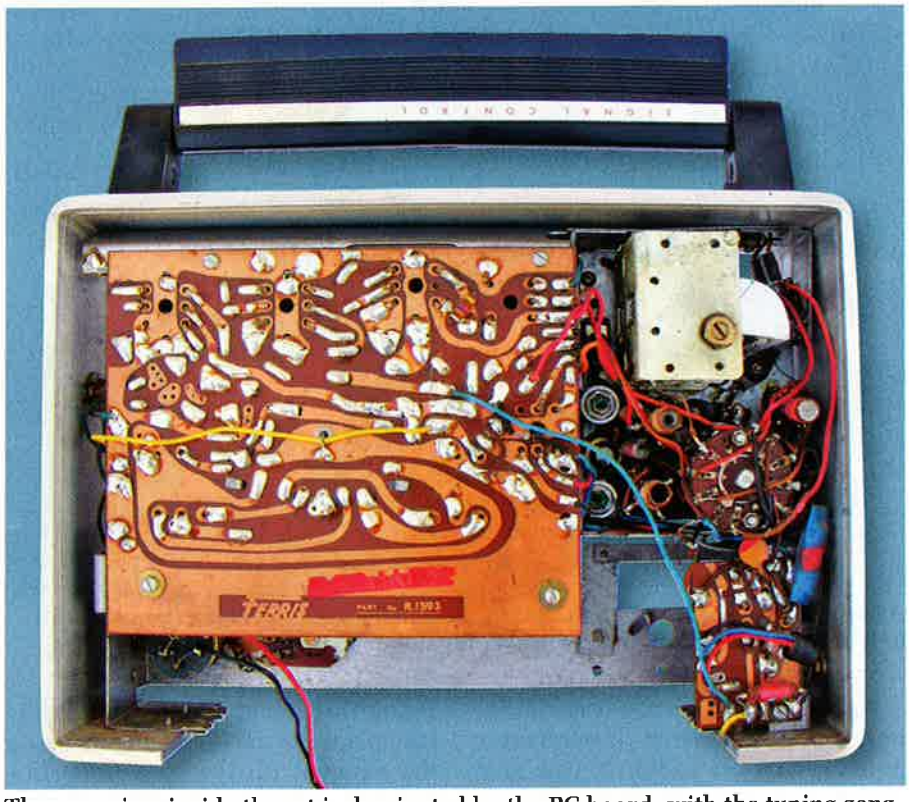
The Ferris multi-purpose model 174 came out in 1963. This set was enclosed in an attractive gunmetal grey aluminium case and measured 255 x 220 x 100mm (W x H x D), including the knobs. The back features a black perforated aluminium sheet while the front also features a perforated aluminium sheet, which is coloured black and off-white.

In keeping with the theme, the knobs are black and white, while the slide-rule dial scale is finished in black, white and blue, with a red dial pointer.

The ferrite rod antenna is encased in a plastic rectangular sleeve, which swivels along its longest axis. It is located on the top of the set and also acts as the carry handle. The cabinet certainly isn't as flashy as some transistor radios of the era but has a real no-nonsense look about it.

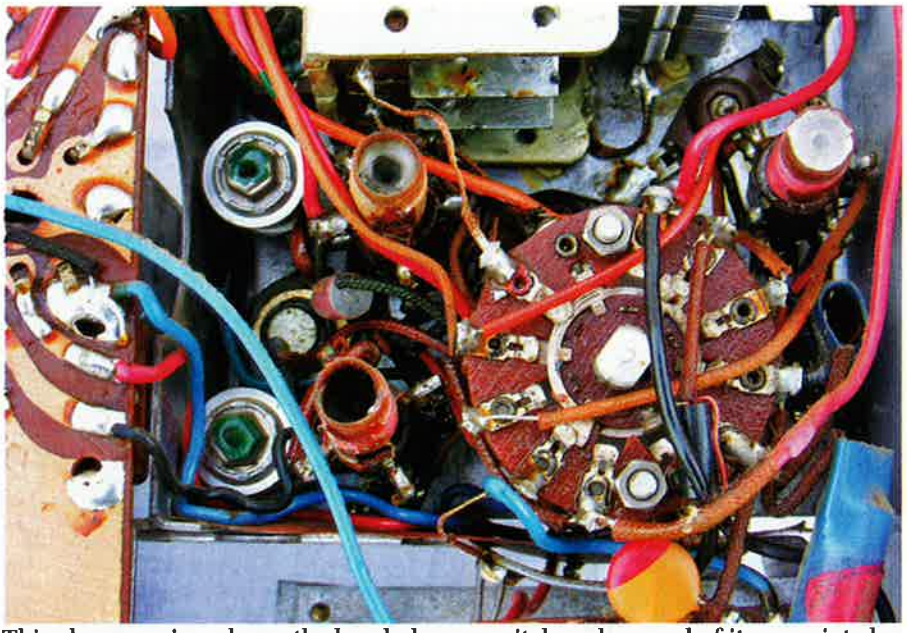


This is the view inside the front of the set with the front panel removed. The cardboard pointer at left indicates the mechanical linkage between the band-change switch and its front-panel control knob.

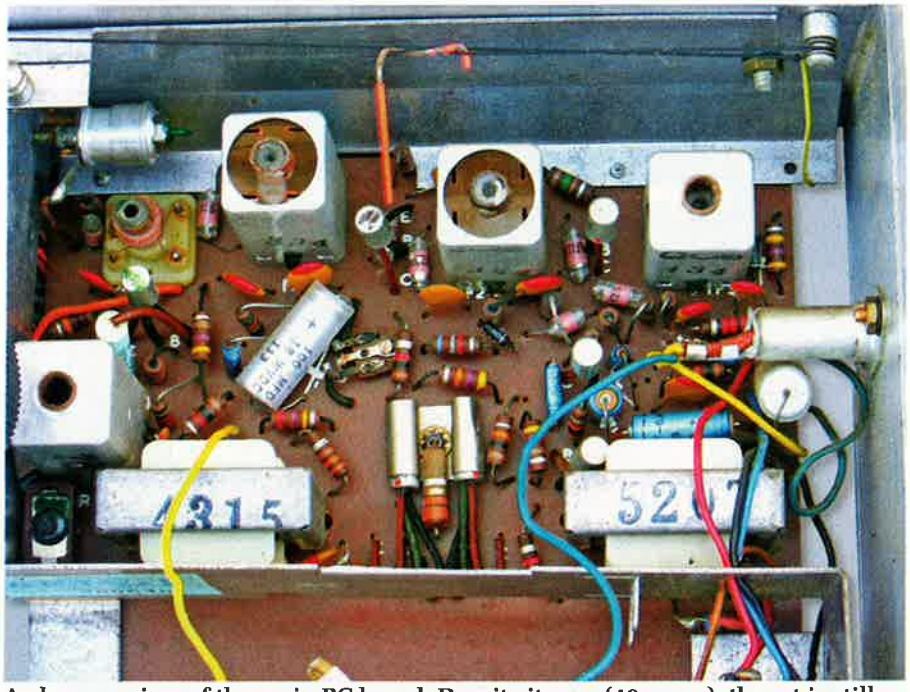


The rear view inside the set is dominated by the PC board, with the tuning gang and band-change switch to the right. The ferrite rod antenna is hidden inside the handle.

The model 174 was produced over a 4-year period until at least 1967 and sold for $124.50 – about 50% more than a good car radio of the era and much more than the average wage at the time. It was supplied complete with a car seat bracket and a wire indoor antenna.



This close-up view shows the band-change switch and several of its associated coils. The switch is used to select between the ferrite loop antenna and a car radio antenna on the medium-wave band and also to select the 2-6MHz and 6-18MHz shortwave bands.



A close-up view of the main PC board. Despite its age (40 years), the set is still in quite good condition and required only minor work to get it going.

Basically, the Ferris 174 was a multi-purpose, 8-transistor, triple-wave, portable-cum-car radio. It was also touted as being quite suitable as a cordless mantel receiver.

Metal case

As was common to most Ferris receivers, the model 174 used a metal case and this ensured good shielding of the circuitry from interference. This meant that signal pick-up could only take place via the car's antenna or via the external (to the case) loopstick antenna. Some extraneous interference may have been able to penetrate the receiver if an external speaker was in use, although this is likely to have been minimal.

In the vehicles of the era, a conventional portable radio sitting on the seat of the car suffered severe interference if the engine was running. There were two reasons for this: (1) interference from the ignition system and other electrical equipment, even if "suppressed", was still high enough to severely mar reception; and (2) the metalwork of the vehicle acted as a Faraday shield and this reduced the signal picked up by the ferrite rod antenna. This shielding effect also acted to concentrate the interference within the cabin of the vehicle.

As a result, most Ferris portables, including the 174, featured a shielded case (just like purpose-built car radios) and included a socket to plug in an external car radio antenna. Ferris did their homework well – their sets worked well in a car but most portables from other manufacturers were unsuitable in this role because the problems outlined above were not addressed.

As well as the car radio antenna, the band switching in the receiver also allows either a long-wire antenna or the loopstick antenna system to be used on the broadcast band (530-1620kHz). On shortwave, the receiver can be switched to cover 2-6MHz or 6-18MHz but must be used with an external antenna, whether in a car, in the home or out in the "bush".

On the shortwave bands, the receiver was often used by people who needed to listen to relatively weak stations such as the Royal Flying Doctor Service, bushfire brigade communications and small ships (fishing boats). It was also used by those who wanted to listen to shortwave services such as the abovementioned ABC inland service, the BBC and VOA, etc.

The set used a No.286 battery which gave up to 1000 hours of operation before replacement was needed. In fact, the set will work with a supply voltage as low as 5V, which meant that every last bit of electrical energy could be wrung out of the battery. This also meant that it was quite economic to use it as a battery-powered domestic receiver (ie, without recourse to the use of a mains power adaptor).

So the Ferris 174 was a very versatile set. At home, it could be powered from a mains adaptor (or from batteries). On the way to the beach, it could easily be connected to the car's radio antenna via the coaxial antenna cable. And at the beach, it could be used as a true portable.

Even so, you probably would not want to have to carry the set too far.

With its battery installed, it weighs in at about 4kg so it is not exactly a lightweight.

Circuit details

Fig.1 shows the circuit details. It uses eight transistors and delivers good sensitivity over the three bands tuned. The transistors are second-generation germanium types, which were more sensitive and had lower noise than the original OC44 and OC45 series.

The input circuit is relatively complex, with a 4-pole 4-position switch section used to select between the ferrite loop antenna and the car antenna (or a long antenna). An OC171 PNP transistor is used as the radio frequency (RF) amplifier and the amplified signal is then fed on to a second OC171, which acts as an autodyne converter.

The various coils (10 in all) are switched using another 10 poles on the 4-position wave-change switch. A total of 20 adjustments is required to accurately align the front-end of the receiver, while the intermediate frequency (IF) amplifier requires a further five adjustments.

Following the converter is a 2-stage IF amplifier based on two OC169 transistors. Neither of these transistor stages is neutralised. Note also that the emitter of the second IF transistor stage is not bypassed, which improves its ability to deal with strong signals.

Following the IF amplifier is an OA91 detector diode. This is biased close to its conduction point by resistors R17, R18 & R19 and this greatly improves the sensitivity of the detector.

A second OA91 diode is used to derive the automatic gain control (AGC) voltage. This voltage is fed to the base of the RF amplifier transistor via R16 & R2. The AGC voltage rises as the signal strength increases, to gradually cut this transistor off. In addition, its emitter is connected to the base circuit of the first IF amplifier (OC169) and so the forward bias on the latter is also reduced, which reduces its gain with strong signals.

Note that the forward bias for the RF stage (OC171) is adjusted by trimpot R3. However, the service manual makes no mention of the circumstances under which R3 is adjusted. In practice, I suspect that it was adjusted during manufacture to give best performance when the receiver was tuned to a weak signal.

Following the detector is a three-stage audio amplifier based on two OC71s and two OC74 transistors. The OC74 class-B output pair are driven in push-pull fashion by transformer T1 and in turn drive the internal loudspeaker via transformer T2.

There is also provision for an external speaker to be plugged in (doing this automatically disconnected the internal unit). This allowed a larger car speaker to be used, to give improved audio performance in a noisy cabin.

Negative feedback in the audio amplifier is derived from one side the speaker-transformer secondary winding. This feedback signal is applied via R36 to the base of the OC71 audio driver-transistor (ie, the transistor driving transformer T1).

Preventing thermal runaway

Germanium transistors are very sensitive to heat and draw more current as they heat up. This increased current then leads to even more heating and can soon escalate into thermal runaway which can destroy the device.

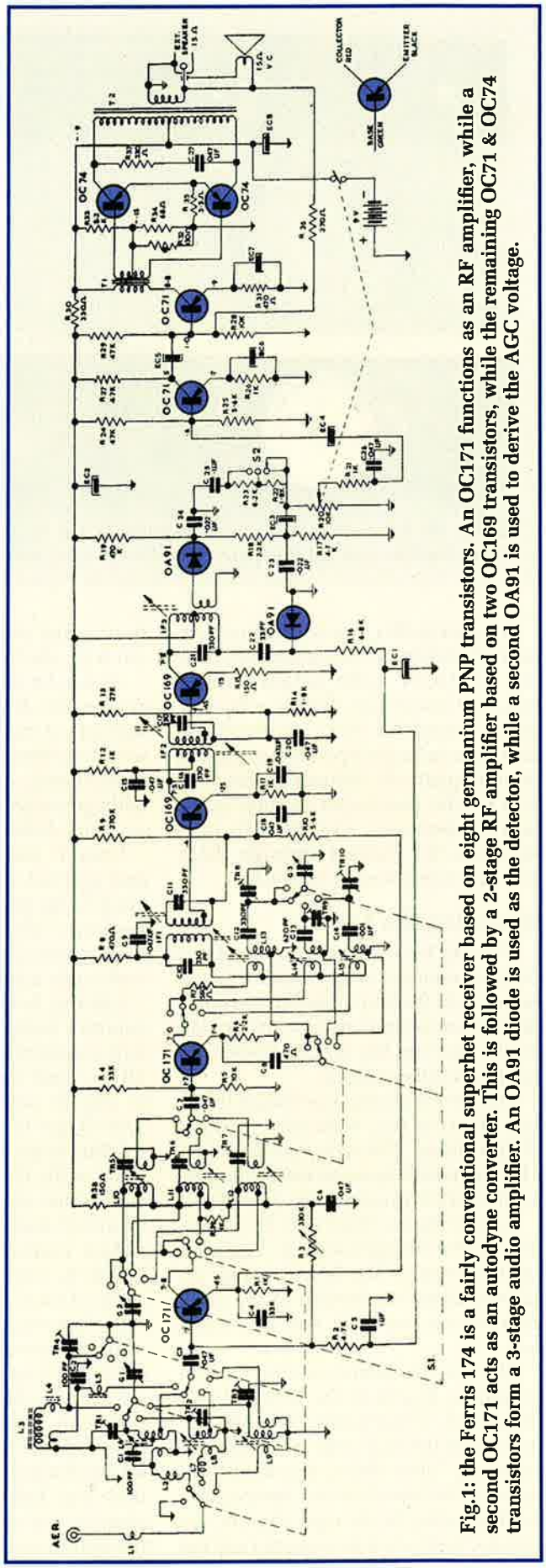
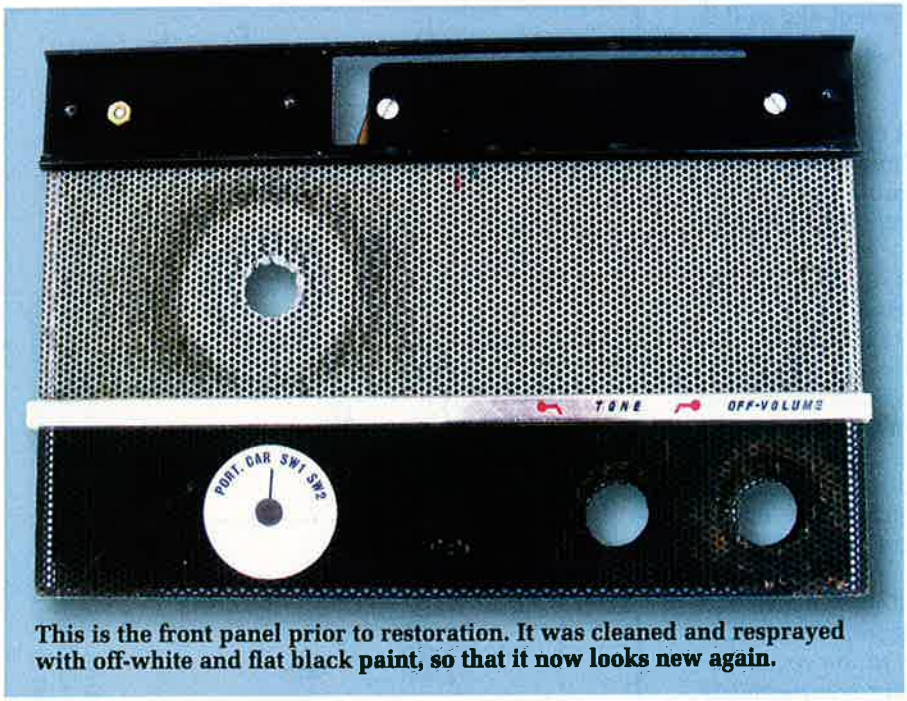


Fig.1: the Ferris 174 is a fairly conventional superhet receiver based on eight germanium PNP transistors. An OC171 functions as an RF amplifier, while a second OC171 acts as an autodyne converter. This is followed by a 2-stage RF amplifier based on two OC169 transistors, while the remaining OC71 & OC74 transistors form a 3-stage audio amplifier. An OA91 diode is used as the detector, while a second OA91 is used to derive the AGC voltage.



This is the front panel prior to restoration. It was cleaned and resprayed with off-white and flat black paint, so that it now looks new again.

To prevent this, special precautions must be taken to thermally stabilise the two OC74 audio output transistors. In this circuit, this is achieved using thermistor R32. Its resistance decreases as the temperature rises and this automatically reduces the forward bias on the transistors as their junction temperatures rise. This in turn stabilises the current through them and prevents thermal runaway.

Restoring the 174

The unit featured here was obtained from a member of my local vintage radio club. It was handed to me completely unrestored and its owner also kindly lent me the service manual to help with this column.

The receiver looked as though it had had plenty of use, with some scuffing of the cabinet. The cabinet also looked a bit shabby in the areas where the perforated aluminium panels are fitted.

Removing the front and back panels is quite straightforward. The back panel is removed by first undoing two screws along the bottom of the case, after which the back can be swung out.

The front panel first requires the dial pointer to be run to the lefthand end of the dial. Three screws are then undone from the dial scale which is then removed. That done, the knobs are removed followed by two more screws on the bottom of the case. Finally, the speaker leads are disconnected and the front panel removed by swivelling it out from the bottom.

As can be seen in one of the photographs, the front panel in particular had lots of marks. I cleaned the mesh with fine wet-and-dry paper and then used a damp, soapy rag to remove any body grease from the front panel. This was then followed with a damp rag.

Once it was cleaned, I masked off and applied some off-white and flat black spray paint to the various panel sections. This considerably improved the appearance of the panel which now looks new again.

Getting back to the receiver, all controls worked as they should and only required a little sewing-machine oil on their various moving surfaces to ensure continued smooth operation. To get into awkward spots, I use a 2.5ml hypodermic syringe partially filled with the required lubricant (I also blunt the needle on a grinder to avoid accidents). That done, the switch contacts were sprayed with Inoxa, as corrosion was evident on some of them.

A close examination of the internals of the set revealed nothing out of the ordinary apart from the RF transistor, which was wrapped in black insulation tape. Unwrapping the transistor revealed that it was not an OC171 but an equivalent in a different package that had been substituted at some stage in the set's life. I got rid of the insulation tape and slipped some neat-fitting black tubing over the transistor to make it look a bit tidier.

Testing the receiver

With everything appearing to be in order, I connected a 9V supply to the set and switched it on. The receiver immediately began operating which was a pleasant surprise. I left it operating for an hour or so and it happily continued playing with no fuss.

It was now time to check and adjust the alignment if necessary. First, I checked the IF alignment and found it to be very slightly out. Unfortunately, I had trouble adjusting one core as a previous owner (not the current owner) had used beeswax to "lock" it in place.

Aligning the three tuned bands also proved to be less than straightforward. The problem here is that the dial scale and the front and back covers of the set must be removed to gain access to the tuning adjustments.

That meant that I couldn't align the set by tuning to various stations and adjusting it so that the dial markings correctly coincided with the pointer. Instead, I had to rely on the tune-up information which specifies the frequencies tuned with the gangs closed and fully open.

Fortunately, this proved to be fairly satisfactory and the calibrations were near enough for all practical purposes. However, I'm quite sure that with a bit more work, Ferris could have designed the cabinet so that the dial-scale could have remained in-situ while the alignment adjustments were carried out.

The next step was to align the broadcast band on the car radio setting of the band-change switch. This went smoothly but because I wasn't using a car radio antenna, trimmer TR1 will probably require further adjustment when the set is actually tested in a car. The oscillator adjustments were accurate enough on all bands, so these were left untouched.

The 2-6MHz band also tuned up easily, as did the 6-18MHz band. However, I had to be careful not to peak the image signal rather than the correct signal on the 6-18MHz band, as image rejection is poor at the top end of this band. In fact, this is a common problem with most sets using a 455kHz IF amplifier.

As before, a few of the coil cores were partially sealed with wax but by picking some of it out, I was eventually

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able to adjust all the coils. The alignment techniques used were covered in my articles for December 2002 and January-February 2003.

The final step in the alignment involves adjusting the loopstick tuned circuit. To gain access to the loopstick antenna, it is necessary to first lift the ends of the Ferris name strip on the handle and then remove the two screws at its ends. That done, you then pull the two sections apart to reveal the loopstick.

Care must be taken here, as it's all too easy for the loopstick to fall out of the handle and break. To adjust it, it is necessary to keep it in the same position as it would normally occupy and slide one of the two coils along the rod for best performance at the low-frequency end of the broadcast band.

It tuned up quite well but when I moved to the high-frequency end of the band, I was unable to peak the circuit correctly. Initially, I tried placing additional fixed capacitors across the trimmer capacitor but to no avail. The circuit was definitely not peaking because when I brought my hand near the loopstick (which added capacitance across the coil) the performance improved.

Wiring error

There was nothing obviously wrong, as the soldered connections and switch contacts were in good order. I then looked to see if anything was wrong with the wiring and it didn't take long to discover that TR4 was wired to the top contact of the switch going to C3 rather than to the bottom of L4. I rewired TR4 to the correct position in the circuit and the tuning adjustments then peaked, just as they should.

Next, I tried adjusting trimpot R3 to see what effect it had and found that it adjusted the receiver's sensitivity. If I adjusted it too far one way, the set would oscillate but the set works quite well with it adjusted just below the point of oscillation.

Further tests showed that the dial drive is quite positive in its action with no discernible backlash, even when tuned to around 17MHz.

I ran the set off a small regulated power supply for all my tests. In practice, the set is designed to run off a 286 battery but these are no longer available. However, WES Components have a 276P battery which should be suitable. Battery packs made up of six 'AA' cells or of six 'C' cells will also easily fit in the battery compartment and it may even be possible to install packs with six 'D' cells.

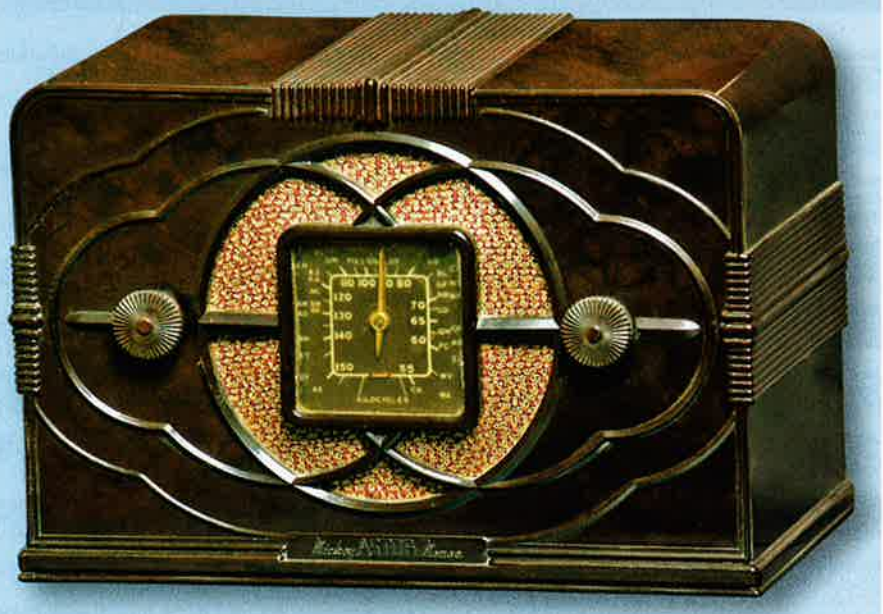
Note, however, that it will be necessary to protect some parts in the set when fitting these replacement batteries. This can be done using pieces of corrugated cardboard around the battery compartment to prevent battery movement.

Summary

The Ferris 174 is one set that lived up to its advertising claims. In fact, I liked it so much that I eventually obtained one for myself.

In summary, this is an excellent receiver that has everything a listener might want except an FM band. SC

Photo Gallery: Astor "Mickey Mouse"



The Astor Mickey came in a very compact cabinet and was one of the earliest Australian bakelite radios, being a modified version of an American receiver. In fact, Astor used American circuits for some years, often changing parts to less than optimum values to save a few pennies.

Early Australian Mickey radios had the name "Mickey Mouse" and a drawing of Mickey on the rear – without an agreement! Astor forgot to tell Disney and Walt Disney was not amused. Legal action resulted in the name being altered to just plain "Mickey", no doubt with Astor pleased to still get some mileage from all their previous advertising.

The receiver was a great performer, considering the component limitations at the time. The valve line-up varied through the model's life but typically included a 5Z4 rectifier, a 25A6 audio output stage and 6Q7, 6K7 and 6A8 valves for the RF and IF stages. Photo supplied by the Historical Radio Society of Australia Inc (HRSA), PO Box 2283, Mt Waverley, Vic 3149. www.hrsa.net.au

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January 1994: 3A 40V Variable Power Supply; Solar Panel Switching Regulator; Printer Status Indicator; Mini Drill Speed Controller; Stepper Motor Controller; Active Filter Design; Engine Management, Pt.4.

February 1994: 90-Second Message Recorder; 12-240VAC 200W Inverter; 0.5W Audio Amplifier; 3A 40V Adjustable Power Supply; Engine Management, Pt.5; Airbags In Cars – How They Work.

March 1994: Intelligent IR Remote Controller; 50W (LM3876) Audio Amplifier Module; Level Crossing Detector For Model Railways; Voice Activated Switch For FM Microphones; Engine Management, Pt.6.

April 1994: Sound & Lights For Model Railway Level Crossings; Dual Supply Voltage Regulator; Universal Stereo Preamplifier; Digital Water Tank Gauge; Engine Management, Pt.7.

May 1994: Fast Charger For Nicad Batteries; Induction Balance Metal Locator; Multi-Channel Infrared Remote Control; Dual Electronic Dice; Simple Servo Driver Circuits; Engine Management, Pt.8.

June 1994: A Coolant Level Alarm For Your Car; 80-Metre AM/CW Transmitter For Amateurs; Converting Phono Inputs To Line Inputs; PC-Based Nicad Battery Monitor; Engine Management, Pt.9.

July 1994: Build A 4-Bay Bow-Tie UHF TV Antenna; PreChamp 2-Transistor Preamplifier; Steam Train Whistle & Diesel Horn Simulator; 6V SLA Battery Charger; Electronic Engine Management, Pt.10.

August 1994: High-Power Dimmer For Incandescent Lights; Dual Diversity Tuner For FM Microphones, Pt.1; Nicad Zapper (For Resurrecting Nicad Batteries); Electronic Engine Management, Pt.11.

September 1994: Automatic Discharger For Nicad Batteries; MiniVox Voice Operated Relay; AM Radio For Weather Beacons; Dual Diversity Tuner For FM Mics, Pt.2; Electronic Engine Management, Pt.12.

October 1994: How Dolby Surround Sound Works; Dual Rail Variable Power Supply; Talking Headlight Reminder; Electronic Ballast For Fluorescent Lights; Electronic Engine Management, Pt.13.

November 1994: Dry Cell Battery Rejuvenator; Novel Alphanumeric Clock; 80-M DSB Amateur Transmitter; 2-Cell Nicad Discharger.

December 1994: Car Burglar Alarm: Three-Spot Low Distortion Sinewave Oscillator; Clifford – A Pesky Electronic Cricket; Remote Control System for Models, Pt.1; Index to Vol.7.

January 1995: Sun Tracker For Solar Panels; Battery Saver For Torches; Dual Channel UHF Remote Control; Stereo Microphone Preamplifier.

February 1995: 2 x 50W Stereo Amplifier Module; Digital Effects Unit For Musicians; 6-Channel LCD Thermometer; Wide Range Electrostatic Loudspeakers, Pt.1; Remote Control System For Models, Pt.2.

March 1995: 2 x 50W Stereo Amplifier, Pt.1; Subcarrier Decoder For FM Receivers; Wide Range Electrostatic Loudspeakers, Pt.2; IR Illuminator For CCD Cameras; Remote Control System For Models, Pt.3.

April 1995: FM Radio Trainer, Pt.1; Balanced Mic Preamp & Line Filter; 50W/Channel Stereo Amplifier, Pt.2; Wide Range Electrostatic Loudspeakers, Pt.3; 8-Channel Decoder For Radio Remote Control.

May 1995: Guitar Headphone Amplifier; FM Radio Trainer, Pt.2; Transistor/Mosfet Tester For DMMs; A 16-Channel Decoder For Radio Remote Control; Introduction To Satellite TV.

June 1995: Build A Satellite TV Receiver; Train Detector For Model Railways; 1W Audio Amplifier Trainer; Low-Cost Video Security System; Multi-Channel Radio Control Transmitter For Models, Pt.1.

July 1995: Electric Fence Controller; How To Run Two Trains On A Single Track (Incl. Lights & Sound); Setting Up A Satellite TV Ground Station; Build A Reliable Door Minder.

August 1995: Fuel Injector Monitor For Cars; A Gain Controlled Microphone Preamp; Identifying IDE Hard Disk Drive Parameters.

September 1995: Railpower Mk.2 Walkaround Throttle For Model Railways, Pt.1; Keypad Combination Lock; Build A Jacob's Ladder Display.

October 1995: 3-Way Loudspeaker System; Railpower Mk.2 Walkaround Throttle For Model Railways, Pt.2; Nicad Fast Charger.

November 1995: Mixture Display For Fuel Injected Cars; CB Transverter For The 80M Amateur Band, Pt.1; PIR Movement Detector.

May 1996: High Voltage Insulation Tester; Knightrider LED Chaser; Simple Intercom Uses Optical Cable; Cathode Ray Oscilloscopes, Pt.3.

June 1996: Stereo Simulator (uses delay chip); Rope Light Chaser; Low Ohms Tester For Your DMM; Automatic 10A Battery Charger.

July 1996: VGA Digital Oscilloscope, Pt.1; Remote Control Extender For VCRs; 2A SLA Battery Charger; 3-Band Parametric Equaliser;.

August 1996: Introduction to IGBTs; Electronic Starter For Fluorescent Lamps; VGA Oscilloscope, Pt.2; 350W Amplifier Module; Masthead Amplifier For TV & FM; Cathode Ray Oscilloscopes, Pt.4.

September 1996: VGA Oscilloscope, Pt.3; IR Stereo Headphone Link, Pt.1; HF Amateur Radio Receiver; Cathode Ray Oscilloscopes, Pt.5.

October 1996: Send Video Signals Over Twisted Pair Cable; 600W DC-DC Converter For Car Hifi Systems, Pt.1; IR Stereo Headphone Link, Pt.2; Multi-Channel Radio Control Transmitter, Pt.8.

November 1996: 8-Channel Stereo Mixer, Pt.1; Low-Cost Fluorescent Light Inverter; Repairing Domestic Light Dimmers.

December 1996: Active Filter For CW Reception; Fast Clock For Railway Modellers; Laser Pistol & Electronic Target; Build A Sound Level Meter; 8-Channel Stereo Mixer, Pt.2; Index To Vol.9.

January 1997: Control Panel For Multiple Smoke Alarms, Pt.1; Build A Pink Noise Source; Computer Controlled Dual Power Supply, Pt.1; Digi-Temp Thermometer (Monitors Eight Temperatures).

February 1997: PC-Controlled Moving Message Display; Computer Controlled Dual Power Supply, Pt.2; Alert-A-Phone Loud Sounding Telephone Alarm; Control Panel For Multiple Smoke Alarms, Pt.2.

March 1997: 175W PA Amplifier; Signalling & Lighting For Model Railways; Jumbo LED Clock; Cathode Ray Oscilloscopes, Pt.7.

April 1997: Simple Timer With No ICs; Digital Voltmeter For Cars; Loudspeaker Protector For Stereo Amplifiers; Model Train Controller; A Look At Signal Tracing; Pt.1; Cathode Ray Oscilloscopes, Pt.8.

May 1997: Neon Tube Modulator For Light Systems; Traffic Lights For A Model Intersection; The Spacewriter – It Writes Messages In Thin Air; A Look At Signal Tracing; Pt.2; Cathode Ray Oscilloscopes, Pt.9.

June 1997: PC-Controlled Thermometer/Thermostat; TV Pattern Generator, Pt.1; Audio/RF Signal Tracer; High-Current Speed Controller For 12V/24V Motors; Manual Control Circuit For Stepper Motors.

July 1997: Infrared Remote Volume Control; A Flexible Interface Card For PCs; Points Controller For Model Railways; Colour TV Pattern Generator, Pt.2; An In-Line Mixer For Radio Control Receivers.

October 1997: 5-Digit Tachometer; Central Locking For Your Car; PC-Controlled 6-Channel Voltmeter; 500W Audio Power Amplifier, Pt.3.

November 1997: Heavy Duty 10A 240VAC Motor Speed Controller; Easy-To-Use Cable & Wiring Tester; Build A Musical Doorbell; Replacing Foam Speaker Surrounds; Understanding Electric Lighting Pt.1.

December 1997: Speed Alarm For Cars; 2-Axis Robot With Gripper; Stepper Motor Driver With Onboard Buffer; Power Supply For Stepper Motor Cards; Understanding Electric Lighting Pt.2; Index To Vol.10.

January 1998: 4-Channel 12VDC or 12VAC Lightshow, Pt.1; Command Control For Model Railways, Pt.1; Pan Controller For CCD Cameras.

February 1998: Telephone Exchange Simulator For Testing; Command Control For Model Railways, Pt.2; 4-Channel Lightshow, Pt.2.

April 1998: Automatic Garage Door Opener, Pt.1; 40V 8A Adjustable Power Supply, Pt.1; PC-Controlled 0-30kHz Sinewave Generator; Understanding Electric Lighting; Pt.6.

May 1998: 3-LED Logic Probe; Garage Door Opener, Pt.2; Command Control System, Pt.4; 40V 8A Adjustable Power Supply, Pt.2.

June 1998: Troubleshooting Your PC, Pt.2; Universal High Energy Ignition System; The Roadies' Friend Cable Tester; Universal Stepper Motor Controller; Command Control For Model Railways, Pt.5.

July 1998: Troubleshooting Your PC, Pt.3; 15W/Ch Class-A Audio Amplifier, Pt.1; Simple Charger For 6V & 12V SLA Batteries; Automatic Semiconductor Analyser; Understanding Electric Lighting, Pt.8.

August 1998: Troubleshooting Your PC, Pt.4; I/O Card With Data Logging; Beat Triggered Strobe; 15W/Ch Class-A Stereo Amplifier, Pt.2.

September 1998: Troubleshooting Your PC, Pt.5; A Blocked Air-Filter Alarm; Waa-Waa Pedal For Guitars; Jacob's Ladder; Gear Change Indicator For Cars; Capacity Indicator For Rechargeable Batteries.

October 1998: AC Millivoltmeter, Pt.1; PC-Controlled Stress-O-Meter; Versatile Electronic Guitar Limiter; 12V Trickle Charger For Float Conditions; Adding An External Battery Pack To Your Flashgun.

November 1998: The Christmas Star; A Turbo Timer For Cars; Build A Poker Machine, Pt.1; FM Transmitter For Musicians; Lab Quality AC Millivoltmeter, Pt.2; Improving AM Radio Reception, Pt.1.

December 1998: Engine Immobiliser Mk.2; Thermocouple Adaptor For DMMs; Regulated 12V DC Plugpack; Build A Poker Machine, Pt.2; Improving AM Radio Reception, Pt.2; Mixer Module For F3B Gliders.

January 1999: High-Voltage Megohm Tester; A Look At The BASIC Stamp; Bargraph Ammeter For Cars; Keypad Engine Immobiliser.

March 1999: Build A Digital Anemometer; DIY PIC Programmer; Build An Audio Compressor; Low-Distortion Audio Signal Generator, Pt.2.

April 1999: Getting Started With Linux; Pt.2; High-Power Electric Fence Controller; Bass Cube Subwoofer; Programmable Thermostat/Thermometer; Build An Infrared Sentry; Rev Limiter For Cars.

May 1999: The Line Dancer Robot; An X-Y Table With Stepper Motor Control, Pt.1; Three Electric Fence Testers; Carbon Monoxide Alarm.

June 1999: FM Radio Tuner Card For PCs; X-Y Table With Stepper Motor Control, Pt.2; Programmable Ignition Timing Module For Cars, Pt.1.

July 1999: Build A Dog Silencer; 10µH to 19.99mH Inductance Meter; Audio-Video Transmitter; Programmable Ignition Timing Module For Cars, Pt.2; XYZ Table With Stepper Motor Control, Pt.3.

August 1999: Remote Modem Controller; Daytime Running Lights For Cars; Build A PC Monitor Checker; Switching Temperature Controller; XYZ Table With Stepper Motor Control, Pt.4; Electric Lighting, Pt.14.

September 1999: Autonomouse The Robot, Pt.1; Voice Direct Speech Recognition Module; Digital Electrolytic Capacitance Meter; XYZ Table With Stepper Motor Control, Pt.5; Peltier-Powered Can Cooler.

October 1999: Build The Railpower Model Train Controller, Pt.1; Semiconductor Curve Tracer; Autonomouse The Robot, Pt.2; XYZ Table With Stepper Motor Control, Pt.6; Introducing Home Theatre.

November 1999: Setting Up An Email Server; Speed Alarm For Cars, Pt.1; LED Christmas Tree; Intercom Station Expander; Foldback Loudspeaker System; Railpower Model Train Controller, Pt.2.

December 1999: Solar Panel Regulator; PC Powerhouse (gives +12V, +9V, +6V & +5V rails); Fortune Finder Metal Locator; Speed Alarm For Cars, Pt.2; Railpower Model Train Controller, Pt.3; Index To Vol.12.

January 2000: Spring Reverberation Module; An Audio-Video Test Generator; Parallel Port Interface Card; Telephone Off-Hook Indicator.

February 2000: Multi-Sector Sprinkler Controller; A Digital Voltmeter For Your Car; Safety Switch Checker; Sine/Square Wave Oscillator.

March 2000: Resurrecting An Old Computer; 100W Amplifier Module, Pt.1; Electronic Wind Vane With 16-LED Display; Build A Glowplug Driver.

May 2000: Ultra-LD Stereo Amplifier, Pt.2; LED Dice (With PIC Microcontroller); 50A Motor Speed Controller For Models.

June 2000: Automatic Rain Gauge; Parallel Port VHF FM Receiver; Switchmode Power Supply (1.23V to 40V) Pt.1; CD Compressor.

July 2000: Moving Message Display; Compact Fluorescent Lamp Driver; Musicians' Lead Tester; Switchmode Power Supply, Pt.2.

August 2000: Theremin; Spinner (writes messages in "thin-air"); Proximity Switch; Structured Cabling For Computer Networks.

September 2000: Swimming Pool Alarm; 8-Channel PC Relay Board; Fuel Mixture Display For Cars, Pt.1; Protoboards – The Easy Way Into Electronics, Pt.1; Cybug The Solar Fly.

October 2000: Guitar Jammer; Breath Tester; Wand-Mounted Inspection Camera; Subwoofer For Cars; Fuel Mixture Display, Pt.2.

November 2000: Santa & Rudolf Chrissie Display; 2-Channel Guitar Preamplifier, Pt.1; Message Bank & Missed Call Alert; Protoboards – The Easy Way Into Electronics, Pt.3.

December 2000: Home Networking For Shared Internet Access; White LED Torch; 2-Channel Guitar Preamplifier, Pt.2 (Digital Reverb); Driving An LCD From The Parallel Port; Index To Vol.13.

January 2001: How To Transfer LPs & Tapes To CD; The LP Doctor – Clean Up Clicks & Pops, Pt.1; Arbitrary Waveform Generator; 2-Channel Guitar Preamplifier, Pt.3; PIC Programmer & TestBed.

February 2001: An Easy Way To Make PC Boards; L'il Pulser Train Controller; A MIDI Interface For PCs; Build The Bass Blazer; 2-Metre Groundplane Antenna; LP Doctor – Clean Up Clicks & Pops, Pt.2.

March 2001: Making Photo Resist PC Boards; Big-Digit 12/24 Hour Clock; Parallel Port PIC Programmer & Checkerboard; Protoboards – The Easy Way Into Electronics, Pt.5; A Simple MIDI Expansion Box.

April 2001: A GPS Module For Your PC; Dr Video – An Easy-To-Build Video Stabiliser; Tremolo Unit For Musicians; Minimitter FM Stereo Transmitter; Intelligent Nicad Battery Charger.

May 2001: 12V Mini Stereo Amplifier; Two White-LED Torches To Build; PowerPak – A Multi-Voltage Power Supply; Using Linux To Share An Internet Connection, Pt.1; Tweaking Windows With TweakUI.

June 2001: Universal Battery Charger, Pt.1; Phonome – Call, Listen In & Switch Devices On & Off; Low-Cost Automatic Camera Switcher; Using Linux To Share An Internet Connection, Pt.2.

July 2001: The HeartMate Heart Rate Monitor; Do Not Disturb Tele-

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August 2001: DI Box For Musicians; 200W Mosfet Amplifier Module; Headlight Reminder; 40MHz 6-Digit Frequency Counter Module; Using Linux To Share An Internet Connection, Pt.3.

September 2001: Making MP3s; Build An MP3 Jukebox, Pt.1; PC-Controlled Mains Switch; Personal Noise Source For Tinnitus; Directional Microphone; Using Linux To Share An Internet Connection, Pt.4.

November 2001: Ultra-LD 100W/Channel Stereo Amplifier, Pt.1; Neon Tube Modulator For Cars; Audio/Video Distribution Amplifier; Build A Short Message Recorder Player; Useful Tips For Your PC.

December 2001: IR Transceiver For PCs; 100W/Ch Stereo Amplifier, Pt.2; Pardy Lights Colour Display; PIC Fun – Learning About Micros.

January 2002: Touch And/Or Remote-Controlled Light Dimmer, Pt.1; A Cheap 'n'Easy Motorbike Alarm; 100W /Channel Stereo Amplifier, Pt.3; Build A Raucous Alarm; FAQs On The MP3 Jukebox.

February 2002: 10-Channel IR Remote Control Receiver; 2.4GHz High-Power Audio-Video Link; Touch And/Or Remote-Controlled Light Dimmer, Pt.2; Booting A PC Without A Keyboard; 4-Way Event Timer.

March 2002: Mighty Midget Audio Amplifier Module; 6-Channel IR Remote Volume Control, Pt.1; RIAA Pre-Amplifier For Magnetic Cartridges; 12/24V Intelligent Solar Power Battery Charger.

April 2002: Automatic Single-Channel Light Dimmer; Pt.1; Water Level Indicator; Multiple-Output Bench Power Supply; Versatile Multi-Mode Timer; 6-Channel IR Remote Volume Control, Pt.2.

May 2002: 32-LED Knightrider; The Battery Guardian (Cuts Power When the Battery Voltage Drops); Stereo Headphone Amplifier; Automatic Single-Channel Light Dimmer; Pt.2; Stepper Motor Controller.

August 2002: Digital Instrumentation Software For PCs; Digital Storage Logic Probe; Digital Therm./Thermostat; Sound Card Interface For PC Test Instruments; Direct Conversion Receiver For Radio Amateurs.

September 2002: 12V Fluorescent Lamp Inverter; 8-Channel Infrared Remote Control; 50-Watt DC Electronic Load; Spyware – An Update.

October 2002: Speed Controller For Universal Motors; PC Parallel Port Wizard; Cable Tracer; AVR ISP Serial Programmer; 3D TV.

November 2002: SuperCharger For NiCd/NiMH Batteries, Pt.1; Windows-Based EPROM Programmer, Pt.1; 4-Digit Crystal-Controlled Timing Module.

December 2002: Receiving TV From Satellites; Pt.1; The Micromitter Stereo FM Transmitter; Windows-Based EPROM Programmer, Pt.2; SuperCharger For NiCd/NiMH Batteries; Pt.2; Simple VHF FM/AM Radio.

January 2003: Receiving TV From Satellites, Pt 2; SC480 50W RMS Amplifier Module, Pt.1; Gear Indicator For Cars; Active 3-Way Crossover For Speakers.

February 2003: PortaPal PA System, Pt.1; SC480 50W RMS Amplifier Module, Pt.2; Windows-Based EPROM Programmer, Pt.3; Fun With The PICAXE, Pt.1.

March 2003: LED Lighting For Your Car; Peltier-Effect Tinnie Cooler; PortaPal PA System, Pt.2; 12V SLA Battery Float Charger; Little Dynamite Subwoofer; Fun With The PICAXE, Pt.2 (Shop Door Minder).

April 2003: Video-Audio Booster For Home Theatre Systems; Telephone Dialler For Burglar Alarms; Three PIC Programmer Kits; PICAXE, Pt.3 (Heartbeat Simulator); Electric Shutter Release For Cameras.

May 2003: Widgybox Guitar Distortion Effects Unit; 10MHz Direct Digital Synthesis Generator; Big Blaster Subwoofer; Printer Port Simulator; PICAXE, Pt.4 (Motor Controller).

June 2003: PICAXE, Pt.5; PICAXE-Controlled Telephone Intercom; PICAXE-08 Port Expansion; Sunset Switch For Security & Garden Lighting; Digital Reaction Timer; Adjustable DC-DC Converter For Cars; Long-Range 4-Channel UHF Remote Control.

July 2003: Smart Card Reader & Programmer; Power-Up Auto Mains Switch; A "Smart" Slave Flash Trigger; Programmable Continuity Tester; PICAXE Pt.6 – Data Communications; Updating The PIC Programmer & Checkerboard; RFID Tags – How They Work.

August 2003: PC Infrared Remote Receiver (Play DVDs & MP3s On Your PC Via Remote Control); Digital Instrument Display For Cars, Pt.1; Home-Brew Weatherproof 2.4GHz WiFi Antennas; PICAXE Pt.7.

September 2003: Robot Wars; Krypton Bike Light; PIC Programmer; Current Clamp Meter Adapter For DMMs; PICAXE Pt.8 – A Data Logger; Digital Instrument Display For Cars, Pt.2.

October 2003: PC Board Design, Pt.1; JV80 Loudspeaker System; A Dirt Cheap, High-Current Power Supply; Low-Cost 50MHz Frequency Meter; Long-Range 16-Channel Remote Control System.

November 2003: PC Board Design, Pt.2; 12AX7 Valve Audio Preamplifier; Our Best Ever LED Torch; Smart Radio Modem For Microcontrollers; PICAXE Pt.9; Programmable PIC-Powered Timer.

December 2003: PC Board Design, Pt.3; VHF Receiver For Weather Satellites; Linear Supply For Luxeon 1W Star LEDs; 5V Meter Calibration Standard; PIC-Based Car Battery Monitor; PICAXE Pt.10.

January 2004: Studio 350W Power Amplifier Module, Pt.1; High-Efficiency Power Supply For 1W Star LEDs; Antenna & RF Preamp For Weather Satellites; Lapel Microphone Adaptor For PA Systems; PICAXE-18X 4-Channel Datalogger, Pt.1; 2.4GHZ Audio/Video Link.

February 2004: PC Board Design, Pt.1; Supply Rail Monitor For PCs; Studio 350W Power Amplifier Module, Pt.2; Shorted Turns Tester For Line Output Transformers; PICAXE-18X 4-Channel Datalogger, Pt.2.

March 2004: PC Board Design, Pt.2; Build The QuickBrake For Increased Driving Safety; 3V-9V (or more) DC-DC Converter; ESR Meter Mk.2, Pt.1; PICAXE-18X 4-Channel Datalogger, Pt.3.

April 2004: PC Board Design, Pt.3; Loudspeaker Level Meter For Home Theatre Systems; Dog Silencer; Mixture Display For Cars; ESR Meter Mk.2, Pt.2; PC/PICAXE Interface For UHF Remote Control.

May 2004: Amplifier Testing Without High-Tech Gear; Component Video To RGB Converter; Starpower Switching Supply For Luxeon Star LEDs; Wireless Parallel Port; Poor Man's Metal Locator.

June 2004: Dr Video Mk.2 Video Stabiliser; Build An RFID Security Module; Fridge-Door Alarm; Courtesy Light Delay For Cars; Automating PC Power-Up; Upgraded Software For The EPROM Programmer.

July 2004: Silencing A Noisy PC; Versatile Battery Protector; Appliance Energy Meter, Pt.1; A Poor Man's Q Meter; Regulated High-Voltage Supply For Valve Amplifiers; Remote Control For A Model Train Layout.

August 2004: Video Formats: Why Bother?; VAF's New DC-X Generation IV Loudspeakers; Video Enhancer & Y/C Separator; Balanced Microphone Preamp; Appliance Energy Meter, Pt.2; 3-State Logic Probe.

September 2004: Voice Over IP (VoIP) For Beginners; WiFry – Cooking Up 2.4GHz Antennas; Bed Wetting Alert; Build a Programmable Robot; Another CFL Inverter.

October 2004: The Humble "Trannie" Turns 50; SMS Controller, Pt.1; RGB To Component Video Converter; USB Power Injector; Remote Controller For Garage Doors & Gates.

November 2004: 42V Car Electrical Systems; USB-Controlled Power Switch (Errata Dec. 2004); Charger For Deep-Cycle 12V Batteries, Pt.1; Driveway Sentry; SMS Controller, Pt.2; PICAXE IR Remote Control.

December 2004: Build A Windmill Generator, Pt.1; 20W Amplifier Module; Charger For Deep-Cycle 12V Batteries, Pt.2; Solar-Powered Wireless Weather Station; Bidirectional Motor Speed Controller.

January 2005: Windmill Generator, Pt.2; Build A V8 Doorbell; IR Remote Control Checker; 4-Minute Shower Timer; The Prawnlite; Sinom Says Game; VAF DC-7 Generation 4 Kit Speakers.

February 2005: Windmill Generator, Pt.3; USB-Controlled Electrocardiograph; TwinTen Stereo Amplifier; Inductance & Q-Factor Meter, Pt.1; A Yagi Antenna For UHF CB; $2 Battery Charger.

March 2005: Windmill Generator, Pt.4; Sports Scoreboard, Pt.1; Swimming Pool Lap Counter; Inductance & Q-Factor Meter, Pt.2; Shielded Loop Antenna For AM; Cheap UV EPROM Eraser; Sending Picaxe Data Over 477MHz UHF CB; $10 Lathe & Drill Press Tachometer.

April 2005: Install Your Own In-Car Video (Reversing Monitor); Build A MIDI Theremin, Pt.1; Bass Extender For Hifi Systems; Sports Scoreboard, Pt.2; SMS Controller Add-Ons; A $5 Variable Power Supply.

May 2005: Getting Into Wi-Fi, Pt.1; Build A 45-Second Voice Recorder; Wireless Microphone/Audio Link; MIDI Theremin, Pt.2; Sports Scoreboard, Pt.3; Automatic Stopwatch Timer.

June 2005: Wi-Fi, Pt.2; The Mesmeriser LED Clock; Coolmaster Fridge/Freezer Temperature Controller; Alternative Power Regular; PICAXE Colour Recognition System; AVR200 Single Board Computer, Pt.1.

July 2005: Wi-Fi, Pt.3; Remote-Controlled Automatic Lamp Dimmer; Lead-Acid Battery Zapper; Serial Stepper Motor Controller; Salvaging & Using Thermostats; Unwired Modems & External Antennas.

August 2005: Mudlark A205 Valve Stereo Amplifier, Pt.1; Programmable Flexitimer; Carbon Monoxide Alert; Serial LCD Driver; Enhanced Sports Scoreboard; Salvaging Washing Maching Pressure Switches.

September 2005: Build Your Own Seismograph; Bilge Sniffer For Boats; VoIP Analog Phone Adaptor; Mudlark A205 Valve Stereo Amplifier, Pt.2; PICAXE in Schools, Pt.4.

October 2005: A Look At Google Earth; Dead Simple USB Breakout Box; Studio Series Stereo Preamplifier, Pt.1; Video Reading Aid For Vision Impaired People; Simple Alcohol Level Meter; Ceiling Fan Timer.

November 2005: Good Quality Car Sound On The Cheap; Pt.1; PICAXE In Schools, Pt.5; Studio Series Stereo Headphone Amplifier; Build A MIDI Drum Kit, Pt.1; Serial I/O Controller & Analog Sampler.

December 2005: Good Quality Car Sound On The Cheap; Pt.2; Building The Ultimate Jukebox, Pt.1; Universal High-Energy Ignition System, Pt.1; Remote LED Annunciator For Queue Control; Build A MIDI Drum Kit, Pt.2; 433MHz Wireless Data Communication.

January 2006: Pocket TENS Unit For Pain Relief; "Little Jim" AM Radio Transmitter; Universal High-Energy Ignition System, Pt.2; Building The Ultimate Jukebox, Pt.2; MIDI Drum Kit, Pt.3; Picaxe-Based 433MHz Wireless Thermometer; A Human-Powered LED Torch.

February 2006: Electric-Powered Model Aircraft, Pt.1; PC-Controlled Burglar Alarm System, Pt.1; Build A Charger For iPods & MP3 Players; Picaxe-Powered Thermostat & Temperature Display; Build A MIDI Drum Kit, Pt.4; Building The Ultimate Jukebox, Pt.3.

March 2006: The Electronic Camera, Pt.1; PC-Controlled Burglar Alarm System, Pt.2; Low-Cost Intercooler Water Spray Controller; AVR ISP SocketBoard; Build A Low-Cost Large Display Anemometer.

April 2006: The Electronic Camera, Pt.2; Studio Series Remote Control Module (For A Stereo Preamplifier); 4-Channel Audio/Video Selector; Universal High-Energy LED Lighting System, Pt.1; Picaxe Goes Wireless, Pt.1 (Using the 2.4GHz XBee Modules).

May 2006: Lead-Acid Battery Zapper & Condition Checker; Universal High-Energy LED Lighting System, Pt.2; Passive Direct Injection (DI) Box For Musicians; Remote Mains Relay Box; Vehicle Voltage Monitor; Picaxe Goes Wireless, Pt.2; Boost Your XBee's Range Using Simple Antennas; Improving The Sound Of Salvaged Loudspeaker Systems.

June 2006: Television – The Elusive Goal, Pt.1; Electric-Powered Model Aircraft, Pt.2; Pocket A/V Test Pattern Generator; Two-Way SPDIF-to-Toslink Digital Audio Converter; Build A 2.4GHz Wireless A/V Link; A High-Current Battery Charger For Almost Nothing.

July 2006: Television – The Elusive Goal, Pt.2; Mini Theremin Mk.2, Pt.1; Programmable Analog On-Off Controller; Studio Series Stereo Preamplifier; Stop Those Zaps From Double-Insulated Equipment.

August 2006: Television – The Elusive Goal, Pt.3; Novel Picaxe-Based LED Chaser Clock; Build A Magnetic Cartridge Preamplifier; An Ultrasonic Eavesdropper; Mini Theremin Mk.2, Pt.2.

September 2006: Thomas Alva Edison – Genius, Pt.1; Transferring Your LPs To CDs & MP3s; Turn an Old Xbox Into A $200 Multimedia Player; Picaxe Net Server, Pt.1; Build The Galactic Voice; Aquarium Temperature Alarm; S-Video To Composite Video Converter.

October 2006: Thomas Alva Edison – Genius, Pt.2; LED Tachometer With Dual Displays, Pt.1; UHF Prescaler For Frequency Counters; Infrared Remote Control Extender; Picaxe Net Server, Pt.2; Easy-To-Build 12V Digital Timer Module; Build A Super Bicycle Light Alternator.

November 2006: Sony Alpha A100 Digital SLR Camera (Review); Build A Radar Speed Gun, Pt.1; Build Your Own Compact Bass Reflex Loudspeakers; Programmable Christmas Star; DC Relay Switch; LED Tachometer With Dual Displays, Pt.2; Picaxe Net Server, Pt.3.

December 2006: Bringing A Dead Cordless Drill Back To Life; Cordless Power Tool Charger Controller; Build A Radar Speed Gun, Pt.2; Heartbeat CPR Training Beeper; Super Speedo Corrector; 12/24V Auxiliary Battery Controller; Picaxe Net Server, Pt.3.

January 2007: Versatile Temperature Switch; Intelligent Car Air-Conditioning Controller; Remote Telltale For Garage Doors; Intelligent 12V Charger For SLA & Lead-Acid Batteries.

February 2007: Remote Volume Control & Preamplifier Module, Pt.1; Simple Variable Boost Control For Turbo Cars; Fuel Cut Defeater For The Boost Control; Low-Cost 50MHz Frequency Meter, Mk.2; Bike Computer To Digital Ammeter Conversion.

March 2007: Programmable Ignition System For Cars, Pt.1; Remote Volume Control & Preamplifier Module, Pt.2; GPS-Based Frequency Reference, Pt.1; Simple Ammeter & Voltmeter.

April 2007: The Proposed Ban On Incandescent Lamps; High-Power Reversible DC Motor Speed Controller; Build A Jacob's Ladder; GPS-Based Frequency Reference, Pt.2; Programmable Ignition System For Cars, Pt.2; Dual PICAXE Infrared Data Communication.

May 2007: 20W Class-A Amplifier Module, Pt.1; Adjustable 1.3-22V Regulated Power Supply; VU/Peak Meter With LCD Bargraphs; Programmable Ignition System For Cars, Pt.3; GPS-Based Frequency Reference Modifications; Throttle Interface For The DC Motor Speed Controller.

June 2007: 20W Class-A Amplifier Module, Pt.2; Knock Detector For The Programmable Ignition; 4-Input Mixer With Tone Controls; Frequency-Activated Switch For Cars; Simple Panel Meters Revisited.

July 2007: How To Cut Your Greenhouse Emissions, Pt.1; 6-Digit Nixie Clock, Pt.1; Tank Water Level Indicator; A PID Temperature Controller; 20W Class-A Stereo Amplifier; Pt.3; Making Panels For Projects.

August 2007: How To Cut Your Greenhouse Emissions, Pt.2; 20W Class-A Stereo Amplifier; Pt.4; Adaptive Turbo Timer; Subwoofer Controller; 6-Digit Nixie Clock, Pt.2.

September 2007: The Art Of Long-Distance WiFi; Fast Charger For NiMH & Nicad Batteries; Simple Data-Logging Weather Station, Pt.1; 20W Class-A Stereo Amplifier; Pt.5.

October 2007: DVD Players – How Good Are They For HiFi Audio?; Electronic Noughts & Crosses Game; PICProbe Logic Probe; Rolling Code Security System, Pt.1; Simple Data-Logging Weather Station, Pt.2; AM Loop Antenna & Amplifier.

November 2007: Your Own Home Recording Studio; PIC-Based Water Tank Level Meter, Pt.1: Playback Adaptor For CD-ROM Drives, Pt.1; Rolling Code Security System, Pt.2; Build A UV Light Box For Making PC Boards.

December 2007: Signature Series Kit Loudspeakers; IR Audio Headphone Link; Enhanced 45s Voice Recorder Module; PIC-Based Water-Tank Level Meter; Pt.2; Playback Adaptor For CD-ROM Drives; Pt.2.

January 2008: Review – Denon DCD-700AE Compact Disk Player; PIC-Controlled Swimming Pool Alarm; Emergency 12V Lighting Controller; Build The "Aussie-3" Valve AM Radio; The Minispot 455kHz Modulated Oscillator; Water Tank Level Meter, Pt.3 – The Base Station; Improving The Water Tank Level Meter Pressure Sensor.

February 2008: UHF Remote-Controlled Mains Switch; UHF Remote Mains Switch Transmitter; A PIR-Triggered Mains Switch; Shift Indicator & Rev Limiter For Cars; Mini Solar Battery Charger.

March 2008: How To Get Into Digital TV, Pt.1; The I^2C Bus – A Quick Primer; 12V-24V High-Current DC Motor Speed Controller, Pt.1; A Digital VFO with LCD Graphics Display; A Low-Cost PC-to-I^2C Interface For Debugging; One-Pulse-Per Second Driver For Quartz Clocks.

April 2008: How To Get Into Digital TV, Pt.2; Charge Controller For 12V Lead-Acid Or SLA Batteries; Safe Flash Trigger For Digital Cameras; 12V-24V High-Current DC Motor Speed Controller, Pt.2; Two-Way Stereo Headphone Adaptor.

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Speed controller causes low-speed "cogging"

I have recently completed the 'Improved Speed Controller For Universal Motors" as featured in the October 2002 issue. It is driving a brush motor rated at 2A; well within the design's 5A rating.

The unit controls OK at the higher speeds. However, when turned down, it "hunts" from a high speed to virtually off and then accelerates back to the high speed and so on. I have had one of the ANU's technicians check the unit but he cannot identify the problem.

Years ago I built the controller's lower-tech predecessor and that controls the motor quite well. Any ideas as to why the newer unit is causing problems? (A. D., via email).

● It is possible that diode D3 is faulty and is causing disruption with the back-EMF and hence the speed control. Note, however, that the minimum speed for an appliance is dependent on the onset of "cogging", where the motor tends to run in short bursts. So VR2 needs to be set so that the minimum speed is high enough so this cogging does not happen.

The slowest minimum speed varies from appliance to appliance.

Simple mixer circuit wanted

I want to build a preamp which will combine the left and right signals from my digital set-top box, to enable me to drive a centre speaker (such as that sold by Dick Smith Electronics). I do not require ultra hifi, as the idea is simply to improve the clarity of speech. What kit(s) can you suggest, please? (T. S., Claremont, WA).

● The easiest way to do this is to make up a mixing lead that connects to the left and right outputs from the digital set-top box and combines the left and right signals using a 10kΩ resistor in each signal wire. The junction of each resistor then becomes the centre channel signal for a power amplifier.

A commercial power amplifier can be used or there are many kit amplifiers available such as the SC480 (Jaycar kit KC-5345) and the accompanying power supply (KC-5347). The required transformer is the MM-1095 from Jaycar. Note that the amplifier and power supply must be built into a suitable case.

If you build your own amplifier, the two 10kΩ mixing resistors for the left and right channel signals can be placed at the signal input to the amplifier rather than using a mixing lead as mentioned above.

Software for Smart Card Programmer

I cannot find files for IC-PROG105a on **www.ic-prog.com** for your Smart Card Programmer (SILICON CHIP, July 2003). I can only find IC-PROG105e. Is this file sufficient? Can I also program the PIC877 smartcard with the same software? (T. T., Westmeadows, Vic).

● The later "e" version of IC-PROG 105 can be used. For the PIC16F877 you need a loader. The GSM a3 gold and silver wafer card loader **http://users.net.yu/~dejan/** should be able to be used. More information is available on the net – see **http://gsmhosting.com/vbb/archive/index.php/t-37383.html**

Speech filter to reduce background noise

I am wondering if you have published a circuit for an audio filter? I am designing some equipment that needs a filter to remove background noise and focus on the frequencies of speech. (N. H., via email).

● Strangely enough, we have not produced an audio "speech" filter although it would be easy enough to do. Basically, you need a combination of a high-pass filter with a low-pass filter. To see examples of high-pass and low-pass filters, have a look at the Subwoofer Controller in the August 2007 issue, specifically at the filter stages involving IC1b (low-pass) and IC5a (high-pass).

You would need to scale the capaci-

Class-A Amplifier Quiescent Current

If one wanted to use the 20W Class-A Amplifier for lower wattage requirements (say around 5-10W), is it possible to alter the design so this can be achieved so that its constant power draw can be maximally reduced? I couldn't readily find how much it draws but the older 15W model was said to constantly draw 100W.

Alternatively, as an innovation, is it possible to come up with a design modification so that the constant power draw (and resulting output wattage) could be changed via a switch or dial, depending on whether a full power mode is required or not? (P. R., via email).

● In setting the bias for a class-A amplifier it is normal to draw load lines and then set the operating current so that the output transistors are fully conducting to provide the peak current through the loudspeaker at full power. In practice, the operating current is half the required peak current at full power. In the case of the 20W Class-A Amplifier, the current is 1.12A, giving a total power draw of 50W per channel.

If you reduced the operating current to 800mA, the maximum class-A power output would be 10W into 8-ohm loads. Similarly, reducing the operating current to around 560mA would give a class-A output of 5W. Switchable bias would be impractical, as you would need separate trimpots and a change of PC board layout.

tors or resistors in the filter networks to provide your speech filter function.

KnightRider works in other cars

I bought a KnightRider scanner kit (SILICON CHIP, May 1996) from Dick Smith Electronics. I would love to mount this kit behind the grille of my car which, to my great dismay, is not a 1980s Pontiac. Ideally, I'd have the circuit mounted under the dash in the cabin and a bunch of cable running from there to a series of 10mm 12V LEDs behind the grille.

Will this kit still work if I were to go ahead and make these modifications? (D. C., via email).

● We regret that your car does not happen to be a 1980s Pontiac.

Fortunately, the KnightRider will work in other cars. To install it, you can run cabling from the PC board to the LEDs but you should not use 12V LEDs. Use standard 10mm LEDs instead. 12V LEDs have an internal resistor to allow direct connection to 12V and they would glow very dimly if used in this circuit.

Question about old electrolytic capacitors

Could you tell me what material is contained within electrolytic capacitors in 1950/60s TVs? (B. K., via email).

● We think that the electrolyte used in those days was based on an ammonium salt, possibly ammonium chloride. Nowadays, boron compounds are used and the electrolytes are a lot more stable.

Does pool monitor adjust for evaporation?

The PIC-Controlled Pool Monitor (SILICON CHIP, January 2008) is a fantastic project but I have a question. Does the PIC compensate for the slow evaporation of water over time or will it suddenly one day trigger because the water level has dropped?

We can lose several inches of water from our pool in a matter of weeks. Conversely, will trickle filling the pool require recalibration? (M. C., via email).

● The pool monitor only monitors for water level changes over a short (10-second) period. Any longer term changes due to leakage, evaporation or filling tend will be ignored.

The alarm function operates so long as the pressure probe is within the water. This gives some 100mm or so water level variation with the alarm still in operation.

Note that sensitivity to changes in water level over the 10-second period will be slightly different with different water levels (and the associated depth that the probe is within the water). However, this is not sufficient to require recalibration.

Transistor failures in SC480 amplifier

I saw a question regarding output transistor failures in the "Ask SILICON CHIP" pages of the February 2008 issue. I built a stereo SC480 system a few years ago and one of the modules kept failing. I replaced transistors several times, checked every node in the circuit and eventually replaced the entire module to no avail.

I also noticed that the failures were often preceded by my old fridge turn-

Weather Satellite Receiver Reception Problems

I have a number of questions on the Weather Satellite Receiver project (SILICON CHIP, December 2003). What is the impedance of the receiver – 50Ω or 75Ω? Also, what is the input and output impedance of the preamplifier. My QFH antenna has a terminating impedance of 50Ω so do I need to transform this to 75Ω or not and if so, how?

I used extra bypass capacitors in the preamplifier and in the receiver, with extra shielding to stop oscillation problems. There has been a big improvement but I still have lots of noise and a weak receive signal.

Is my reception problem likely to be due to interference from paging services at 148MHz at my location? Is the receiver's sensitivity in question or can I get better reception from a cheap scanner?

I mounted the turnstile antenna reflector on my QFH antenna with about 650mm spacing from the bottom. Why do I get a stronger signal with the antenna about half a wavelength off the ground as opposed to when it is on the chimney? (D. K., via email).

● We will answer your questions in the order that you asked them. The input impedance of the receiver itself is typically very close to 75Ω when the front-end is tuned. The input and output impedance of the RF preamp are both also very close to 75Ω, hence the suggested use of a matching section in the lead from the turnstile antenna – see page 36 of the January 2004 issue of SILICON CHIP.

You probably don't need a matching section or other impedance transformer to connect a 50Ω antenna to the RF preamp input.

You may still be getting a small amount of oscillation in the receiver's front-end or IF section. You may need further shielding and bypassing around the SA605D and possibly around the BF998 in the receiver.

It's also possible that some of your troubles are due to interference from pagers. If so, it may be necessary to add a bandpass filter in the line between the antenna and the RF preamp.

We doubt if you would get better NOAA satellite reception using a cheap scanner, unless the receiver is still being severely desensitised because of either interference or RF/IF oscillation.

It's hard to explain why reception can be better closer to the ground than further away. Factors like ground conductivity, surrounding metalwork (like metal roofing) and similar things probably play a role.

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Reversing A Brushless DC Motor

I would like to know how to reverse the direction of a permanent magnet brushless DC motor, eg, CPU cooling fans or solar-powered exhaust fans. I know this capability does exist but it is not well known or used.

The reason is that sometimes it is better to bring air in instead of exhausting it out, so it would be good to have a control to reverse the direction of rotation, whether that be manually or automatically switched.

I am fairly familiar with motor types and their functions and realise that brushed DC motors can be reversed by changing the input polarity. However, I am specifically asking about brushless DC motors as they are very efficient and can be run of both DC and AC (after conversion). I understand that they cannot be reversed by changing polarity via the use of a DPDT switch or some other means.

Your assistance would be greatly appreciated. Here is one link to a company in America that has this function for its Solar DC Cooling, Fans & Kits – see **http://www.advancedenergyonline.com/catalog/applications/fans.htm**

They say "The reversible, ball bearing PM motor allows the fan to be used for intake or exhaust by reversing the wire at the motor." (M. D., Cairns, Qld).

● Whether a (permanent magnet) brushless DC motor can be reversed or not depends on the circuitry that switches the coils. With some, the coils are switched using timing information from Hall effect or magnetic sensors. The switching circuit then keeps the coils powered at the correct time to ensure the motor runs in the correct direction. Reversing the supply will just prevent the circuit receiving power because it includes a blocking diode for the supply.

Alternatively, a diode bridge could be used to allow the circuit to run with either polarity but with a polarity sensor that alters the coil switching sequence according to applied polarity. This can reverse the motor direction.

Some brushless motors do not use any synchronising signal but just sequence the powering of the coils (assuming the motor will run at a set speed). This is OK for motors that have a constant load such as fans. Again, depending on the design the motor may also be reversible. If you have access to the (usual) three wires which actually power the motor, it may be possible to reverse direction by swapping two of the connections.

Note, however, that reversing the direction of a fan motor, particularly those mounted within a fan cowling, does not work, as they do not move air efficiently in the opposite direction. They tend to just disturb the air when rotating backwards. The fan blades and cowling are designed for one way only.

ing on. I finally fixed the problem – the speaker output wires were routed near the primary of the power transformer and when I moved these wires to the other side of the transformer, the unit functioned properly and has for the past three years without issue.

I suspect that noise in the mains was triggering instability in the power section. (I. M., via email).

● Possibly the fact that the speaker leads were very close to the mains wires may mean that there was direct induction of transient voltages into the amplifier output stage. Even so, the output filter should have stopped most of this effect.

Non-inductive resistors for amplifier

I wish to build a 20W Class-A Stereo Amplifier, as per the series of articles that appeared in SILICON CHIP in 2007. However, I read a report on the DVT website, stating that the author built one and found it was oscillating at above 160kHz and regularly blowing output transistors.

Are there any later notes I should be aware of, eg, avoiding the use of inductive emitter resistors (an early fault with the 1980s ETI Series 5000 Mosfet amplifier)? (P. R., Noosa, Qld).

● There is no such problem in the 20W Class-A Amplifier. If someone is experiencing 160kHz oscillation in their amplifier it points to incorrect components or perhaps a missing or wrong value compensation capacitor associated with Q8, ie, the 100pF NPO ceramic.

Non-inductive resistors have no merit in a class-A circuit. They do have some application in class-B circuits where inductive resistors can magnify the crossover "discontinuity" in the transfer characteristic and even then they are more applicable to Mosfet power amplifiers than bipolar transistor circuits.

Increasing the gain of the RIAA preamp

I need to increase the gain of the Universal Stereo Preamplifier (SILICON CHIP, April 1994) in RIAA mode to match other inputs. Can you suggest a modification to do this?

Changing the value of R4 appears to be the way to do this but I am concerned about affecting the equalisation. (J. P., via email).

● R4 is the one to reduce to get more gain but unfortunately there is not a lot of extra gain to be had. You really need a higher gain circuit such as the Magnetic Cartridge Preamplifier described in the August 2006 issue.

45s Voice Recorder has poor signal/noise ratio

I have a question concerning the 45-Second Voice Recorder (SILICON CHIP, December 2007). My module appears to be working as intended. However the signal-to-noise ratio is rather lower than I had expected, with quite audible background noise which does not vary with AGC action on the input signal amplitude.

I have measured the peak signal/noise ratio as about -30dB (measured by my CRO on the output RCA connector). The peak-to-peak signal on well-recorded voice is about 1.2V. On the same recording with the microphone capsule itself short-circuited, the peak-

to-peak random noise is about 40mV, hence giving about -30dB.

I have verified that the LM358 is working correctly on both differential inputs from the HK828. These measurements were made at highest quality (OscR = 24kΩ). There is no hum and the noise is apparently being generated internally by the HK828.

I have checked the HK828 data sheet and note that it stores 256 voltage levels. I would therefore have expected something over -40dB S/N.

Could you please tell me if this noise is normal or what the cause may be? (G. J., Emerald, Vic).

● Although the HK828 does store samples at 256 voltage levels, they are stored in analog "charge" form rather than in digital. We suspect that is why the signal to noise ratio is not as good as one would expect from a digital memory device offering the same nominal 8-bit resolution.

The figure that you are getting is about as good as you can get from this chip. It seems adequate in practice for many applications.

Pushbutton Control For CD-ROM Drive Adaptor

Thank you for providing a practical use for out-of-date drives with the Playback Adapter for CD-ROM Drives (SILICON CHIP, November & December 2007). These computer drives are of better quality than those in cheap combination sound systems.

Could you also produce a pushbutton panel to go on the front of an older computer tower? The remote control is a great idea but I always like to use manual controls as well. The buttons would have to be Stop, Play, Forward & Reverse. (R. P., via email).

● While it would be nice to have a panel of pushbuttons to control the CD-ROM playback adaptor, it turns out to be a bit of a tall order.

As the circuit stands at the moment, there are no free input pins on the existing microcontroller. It would require another PC board incorporating the pushbuttons and a small microcontroller. The microcontroller would decode and debounce the pushbuttons and then send a serial stream to the main board.

In fact, you would probably want the infrared remote control sensor (IRD1) on the pushbutton panel as well. So the second microcontroller would decode the pushbuttons and the infrared remote control signals. These would then be fed to the main board through the input pin that the infrared remote control sensor is connected to presently (ie, pin 12 [PD2] of the microcontroller).

So what you are asking for, while seemingly simple, is a lot more complicated to implement. We do not think it is worth pursuing as the all-up cost of the resulting project would be far more than buying a good quality DVD player.

Missing track on PC board

I read about D.P.'s problem with the Programmable Ignition display on page 98 of the February 2008 issue. I too had no display – "boxes" only.

The problem was a missing PC track between the top of the SIP resistor array and pin 14 of the LCD module. It was just next to the top left mounting bolt. (J. Y., Milang, SA).

Processor for subwoofer amplifiers

I have a suggestion for an up-coming project. Following on from the previous sub processors for subwoofer amplifiers, how about tackling the other end of the frequency range? By that I refer to the 10Hz -20Hz region, where most subwoofer speakers are totally unprotected from peak signals often well below the tuning frequency of the box (vented high-pass types in particular).

What is needed is variable subsonic filter with a slope of at least 24dB which can be adjusted using a potentiometer.

The second thing that is required is some form of limiter (compression?) to limit the signal if required. Again this could be made adjustable. The third requirement would be to have a narrow-band EQ feature to boost the low frequencies to compensate for output losses in high excursion (and often expensive!) low-frequency drivers. (J. P., via email).

● The Subwoofer Controller project in the August 2007 issue did incorporate a low-pass filter with a roll-off at 15Hz.

We don't think there is much point in having it adjustable. However, if you wanted to increase the roll-off frequency to 20Hz, you could do so by scaling the relevant capacitors. The circuit also incorporates an adjustable narrow-band equaliser.

Current flow in class-B amplifier

I am having trouble understanding the direction of current flow in simple class-B amplifiers with and without an AC signal. I would appreciate some help. (W. S., via email).

● Look at it this way: for positive excursions of a sinewave, the upper transistor conducts and feeds current from the positive rail to the loudspeaker. For negative excursions, the lower transistor conducts and pulls current back from the loudspeaker to the negative supply. With no signal, no current flows through the loudspeaker.

Induction cook tops are expensive

I am currently in the market for a new stove and I want to know how much more efficient is an induction cook top compared to a halogen cook top? Are there any bad health side effects that could occur as a result of using an induction cook top? And how does an induction cook top work?

I am also interested in how a halogen cook top works but I have probably already asked too many questions! (L. M., Lakes Entrance, Vic).

● We do not have comparative efficiency figures for cook tops although the induction type should be the most efficient. It works by inducing an intense alternating magnetic field into the base of the saucepan. The resulting eddy currents in the base of the saucepan cause heating.

In effect, all the power being used goes into the base of the saucepan but there will inevitably be some losses (ie, inefficiency) in the large electromagnet coil used to induce the magnetic fields. There are no health side effects

15 And 30 Farad Capacitors

I was recently interested to see the availability of 15 and 30 Farad capacitors for bolstering the 12V battery line in car sound systems. Made by Stinger in the USA, they are priced at US$500 and US$650, respectively.

Do you think these are worthwhile? (P. K., Gulgong, NSW).

● Such capacitors are a complete waste of money. It is true that a big lump of bass may cause a momentary drop in the amplifier's supply rails but any such drop is more likely in the high-voltage rails from the amplifier's internal inverter, not the battery supply itself.

If the amplifier rails do drop because of limitations in the inverter, an external capacitor cannot help. And even if the amplifier rails do drop, it will make no difference to the sound quality.

The only time that a momentary drop in the supply rails could cause problems is if the amplifier is very close to full power and the slight voltage drop then causes it to go into clipping. If you are pushing the system that hard, it must be "rooly rooly loud". Nor will driving an amplifier into clipping cause any damage to the amplifier itself, although it may damage tweeters.

In practice, you would be better off installing another car battery in the vehicle, close to the amplifier. You would save heaps of money, based on those prices, and end up with a better result. Those super capacitors with digital readouts look pretty snazzy though.

Notes & Errata

12-24V High Current Speed Controller, March & April 2008: the component overlay (page 65, April 2008) shows a 100µF capacitor immediately to the right of LK14. This should be a 470µF 16V electrolytic. Similarly, the component overlay shows a 220nF MKT capacitor in parallel with zener diode ZD6. This should be a 100nF MKT capacitor.

to cooking in this way.

Note that induction cook tops are very expensive and you can only use certain steel and cast iron saucepans – all others will be unsuitable (eg, those with aluminium or copper bases).

Halogen cook tops use essentially the same technology as halogen lamps except that the light from the lamp must pass through an infrared filter, ie, the glass cook top. As a result, the cook top becomes hot and heats up the saucepan. Having said that, we cannot see any particular benefit of halogen cook tops although they may heat up more rapidly than other types.

If you want to be environmentally friendly, the best bet is a gas cook top. It will also allow you to keep cooking if you have a power blackout. There is more information at this website: **http://www.choice.com.au/viewArticle.aspx?id=103867&catId=100447&tid=100008&p=1&title=Test%3a+Induction+cooktops+(archived)**

Switched volume control wanted

I am looking for a circuit diagram of a switch-controlled (not a potentiometer) volume control. I am repairing an old ACCUPHASE-202 amplifier of great sentimental value and cannot obtain the original or any dual 250kΩ log potentiometer. Would it be possible to build in a switch-controlled volume control? (R. N., Geraldton, WA).

● Switched volume controls are possible but you do not get enough steps and so the volume change for each step is too large. A better approach may be to substitute a pot that is close enough – say 100kΩ. The effect on performance will probably be minimal.

Does regulator need a heatsink?

I have purchased the Adjustable Regulated Power Supply kit (SILICON CHIP, May 2007). The directions state that I may need to install a heatsink.

I intend to regulate four 3.7V (14.8V) Li-ion 3.3Ah batteries to give an output of 7V at 1A. Do I need to install a heatsink and what heatsink should I use? (S. C., via email).

● If you mean that the regulator is required to deliver 7V at 1A with a 14.8V input, then you need a heatsink. The dissipation is 7W and so a low thermal resistance heatsink (<2.5°C/W) such as Jaycar's HH-8570 fan type should be used. SC

WARNING!

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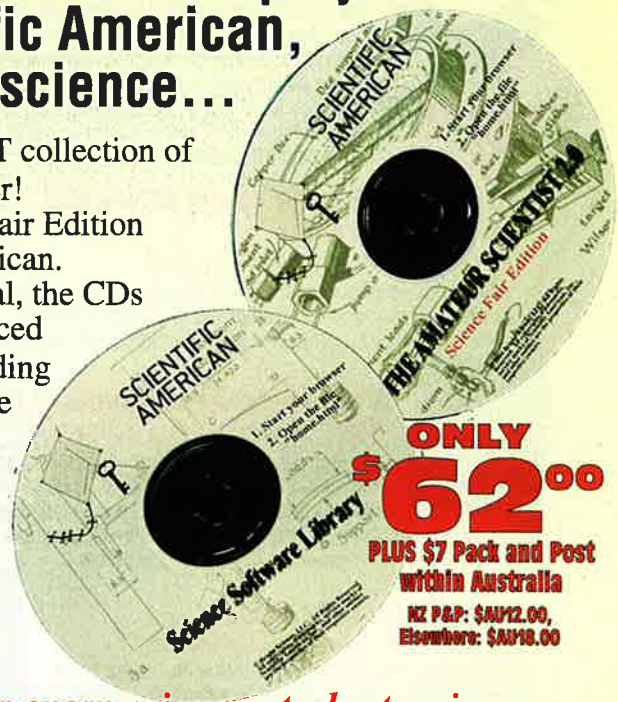

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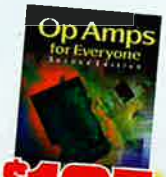

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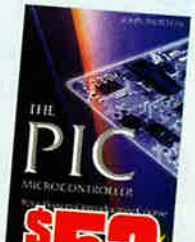

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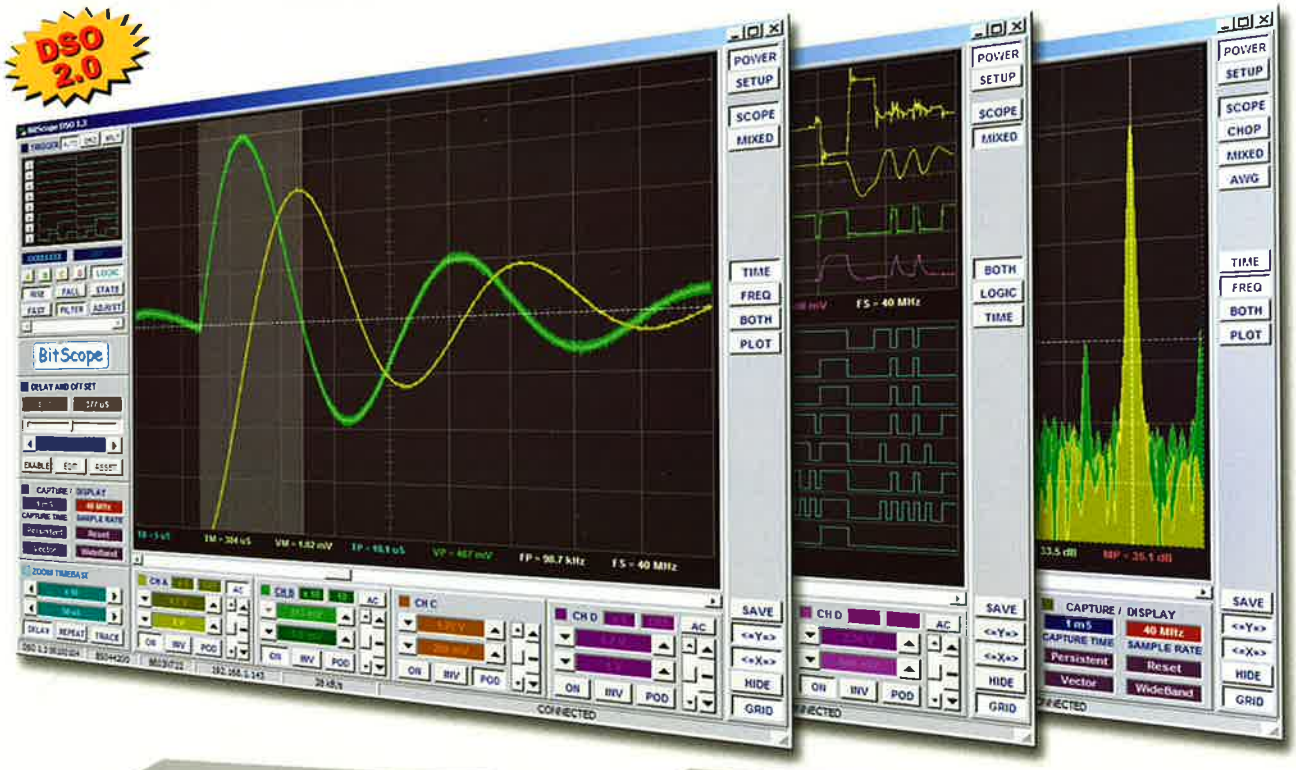
PC Boards

Printed circuit boards for SILICON CHIP designs can be obtained from RCS Radio Pty Ltd. Phone (02) 9738 0330. Fax (02) 9738 0334.

BitScope PC Oscilloscopes & Analyzers

DSO Test Instrument Software for BitScope Mixed Signal Oscilloscopes



4 Channel BitScope

2 Channel BitScope

Pocket Analyzer

Digital Storage Oscilloscope
✓ Up to 4 analog channels using industry standard probes or POD connected analog inputs.

Mixed Signal Oscilloscope
✓ Capture and display up to 4 analog and 8 logic channels with sophisticated cross-triggers.

Spectrum Analyzer
✓ Integrated real-time spectrum analyzer for each analog channel with concurrent waveform display.

Logic Analyzer
✓ 8 logic, External Trigger and special purpose inputs to capture digital signals down to 25nS.

Data Recorder
✓ Record anything DSO can capture. Supports live data replay and display export.

Networking
✓ Flexible network connectivity supporting multi-scope operation, remote monitoring and data acquisition.

Data Export
✓ Export data with DSO using portable CSV files or use libraries to build custom BitScope solutions.

BitScope DSO Software for Windows and Linux

BitScope DSO is fast and intuitive multi-channel test and measurement software for your PC or notebook. Whether it's a digital scope, spectrum analyzer, mixed signal scope, logic analyzer, waveform generator or data recorder, BitScope DSO supports them all.

Capture deep buffer one-shots or display waveforms live just like an analog scope. Comprehensive test instrument integration means you can view the same data in different ways simultaneously at the click of a button.

DSO may even be used stand-alone to share data with colleagues, students or customers. Waveforms may be exported as portable image files or live captures replayed on other PCs as if a BitScope was locally connected.

BitScope DSO supports all current BitScope models, auto-configures when it connects and can manage multiple BitScopes concurrently. No manual setup is normally required. Data export is available for use with third party software tools and BitScope's networked data acquisition capabilities are fully supported.

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